Annual Extra Number

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AUTOMOBILE ENGINEER

Vol 50 No 12

28 NOVEMBER 1960

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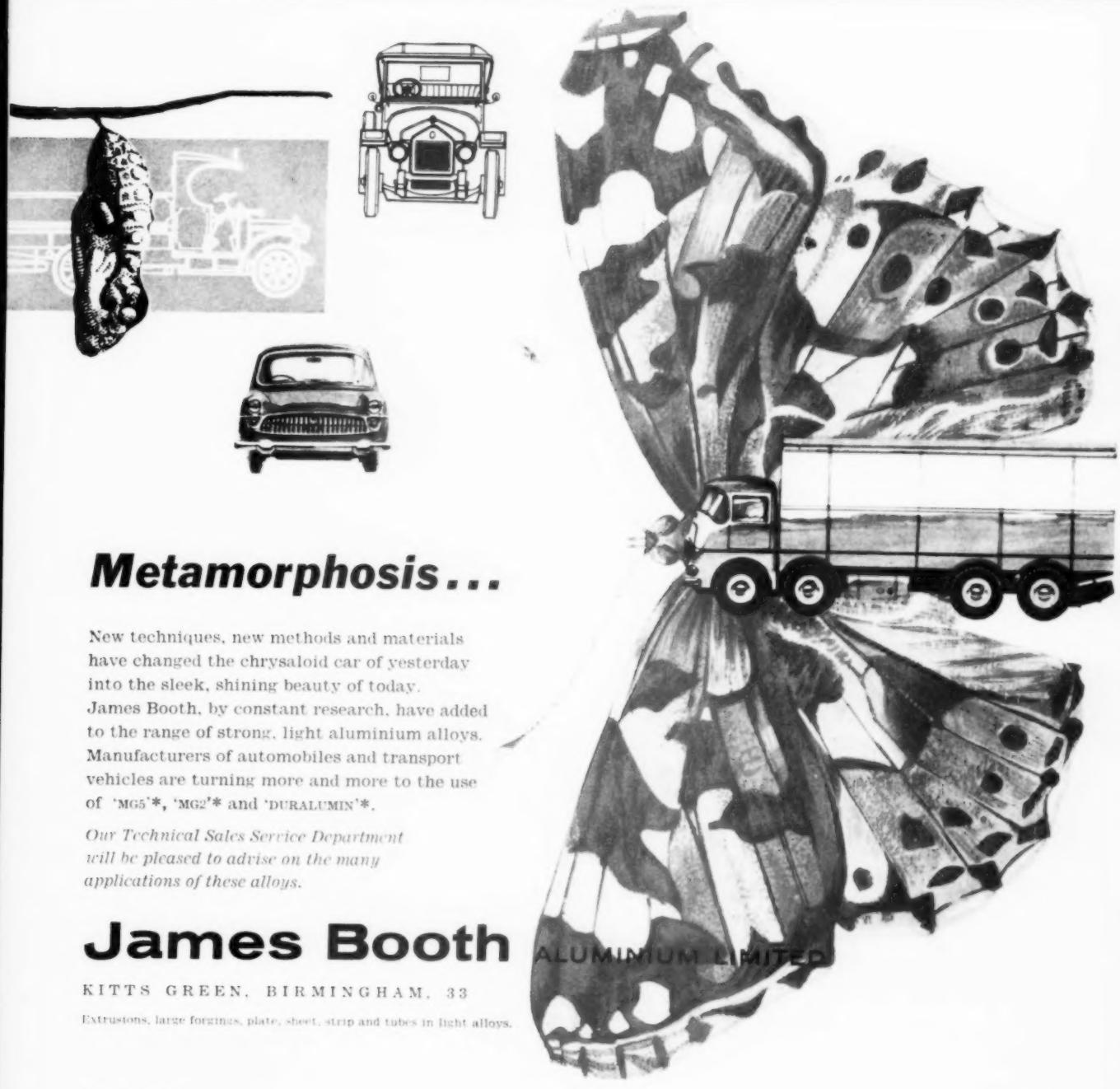

Metamorphosis...

New techniques, new methods and materials have changed the chrysaloid car of yesterday into the sleek, shining beauty of today. James Booth, by constant research, have added to the range of strong, light aluminium alloys. Manufacturers of automobiles and transport vehicles are turning more and more to the use of 'MG5'*, 'MG2'* and 'DURALUMIN'*.

Our Technical Sales Service Department will be pleased to advise on the many applications of these alloys.

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KITTS GREEN, BIRMINGHAM, 33

Extrusions, large forgings, plate, sheet, strip and tubes in light alloys.

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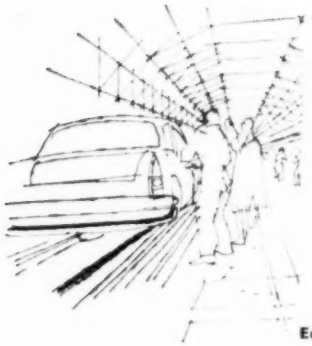
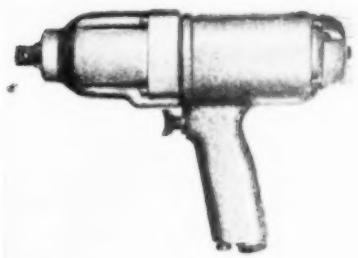


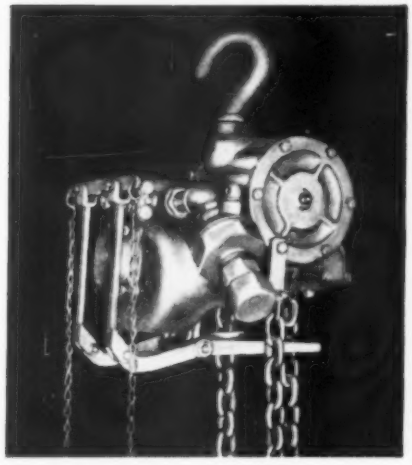
Ecco 40 Spray Gun

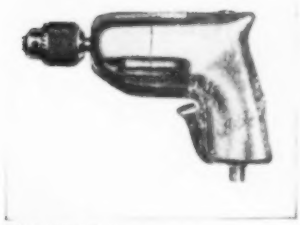


LMS 25 Impact Wrench

LSS 62 Surface Grinder

MT505 Hoist





RAB 200 Drill

Here's AIR POWER for production line efficiency

Atlas Copco's range of equipment for the motor industry includes air-powered tools anatomically designed and balanced to speed up production and reduce operator fatigue. With their excellent power weight ratios, these tools make an important contribution towards higher productivity.

Wherever there are nuts to be tightened, screws to be driven, loads to be lifted or surfaces to be smoothed and painted, Atlas Copco can supply reliable, high-performance, air-powered equipment, together with stationary compressors for every requirement from operating a spray gun, to supplying the complete air needs of a large factory.

Write for literature!

Leaflets and folders describing Atlas Copco compressors and equipment are readily available on request. Write, indicating the type of equipment in which you are interested, to your local Atlas Copco company or agent or to the address below.

Sales and service in over ninety countries

Atlas Copco is the world's largest organisation specialising solely in compressed air equipment. Wherever you are, the international Atlas Copco group offers expert advice on the selection of equipment and provides a complete after-sales service.

Atlas Copco puts compressed air to work for the world

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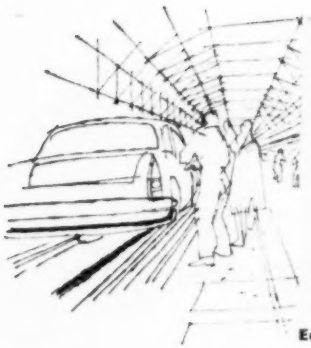

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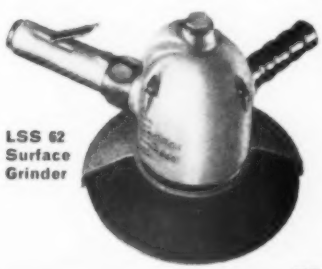

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The Spiral Tube "Air-Towel" has been awarded the certificate of the Royal Institute of Public Health and Hygiene for Hygienic Merit.

★ *Write NOW for full particulars to: Air Towel Division, (Dept. A.E.)*

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Quicker Hand Dryer!

No queueing up to dry, and constant complaints about wet or grubby towels, when SPIRAL TUBE "Air Towels" are installed! Designed for high-speed hygienic drying of hands, face and arms and hair, the "Air Towel" never gets wet. Deals with up to 40 persons per dryer per 5 minutes. Slashes towel costs. Prevents spread of infection. Operates from factories' own steam or H.P. hot water supply. A self-contained unit—easy to install. Robustly constructed for long trouble-free service. 2-, 4- and 8-man models available.

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The "Margam Abbey"—built for the Port Talbot Pilotage Authority by Richard Ironworks Ltd., in which Cor-Ten was used extensively. Photograph by courtesy of the Port Talbot Pilotage Authority

COR-TEN GOES DOWN TO THE SEA IN SHIPS

At sea as well as ashore new uses are constantly being found for SCW Cor-Ten. It was used extensively in the construction of this vessel for the Port Talbot Pilotage Authority.

The Main Deck and Bulwark Plating
Shell Plating and Anchor Recess
Floors and Engine Seating
Chain Locker
Fresh Water Tank
Bulkhead Bottom Plating
Rudder Side Plates

—were made entirely from Cor-Ten. A typical example of the growing use of Cor-Ten in marine construction, and in other fields where high yield strength, together with outstanding resistance to corrosion, is vital.

COR-TEN IS TOUGHER

Weight for weight, the yield strength of SCW Cor-Ten is 50% higher than ordinary mild steel.

Alternatively—
Strength for strength, a saving of 1/3 of the weight is possible.

4-6 times more resistant to atmospheric corrosion. Highly resistant to abrasion and fatigue.

COR-TEN SAVES MONEY

Initial costs are spread over a longer service life.

Maintenance costs are reduced.

Operating costs are lowered—in transport, payloads are bigger because of reduction in tare weight.

Please write to us at the address below for further information or for technical assistance in the application of SCW Cor-Ten to your products.

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RAILWAY ROLLING STOCK. AGRICULTURAL AND EARTH-MOVING EQUIPMENT. MINE CARS. POWER STATIONS INSTALLATIONS. BARGES AND SMALL CRAFT

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The assembly line of Ford Motor Company Ltd. at Dagenham, where "BROOMWADE" Compressed Air equipment is used.

Photograph by courtesy of Ford Motor Company Ltd.

Men who build cars use "BROOMWADE" Air Compressors & Pneumatic Tools

YOUR BEST INVESTMENT

British Cars have won a world-wide reputation for design and quality. The demand is increasing. As a result, new factories with longer production lines are being built and equipped with the most modern equipment.

For many years, "BROOMWADE" pneumatic equipment has served this industry well and it is significant that the demand for "BROOMWADE" products is also increasing. There are outstanding reasons for this—ECONOMY, EFFICIENCY and RELIABILITY coupled with intensive research and development to keep "BROOMWADE" Air Compressors and Pneumatic Tools up-to-date with modern trends and requirements.

In addition, "BROOMWADE" Technical Representatives and Service Engineers are works trained to provide customers with the best advice and service.

"BROOMWADE" manufacture a wide range of Air Compressors and Pneumatic Tools covering the requirements of the engineering industry.

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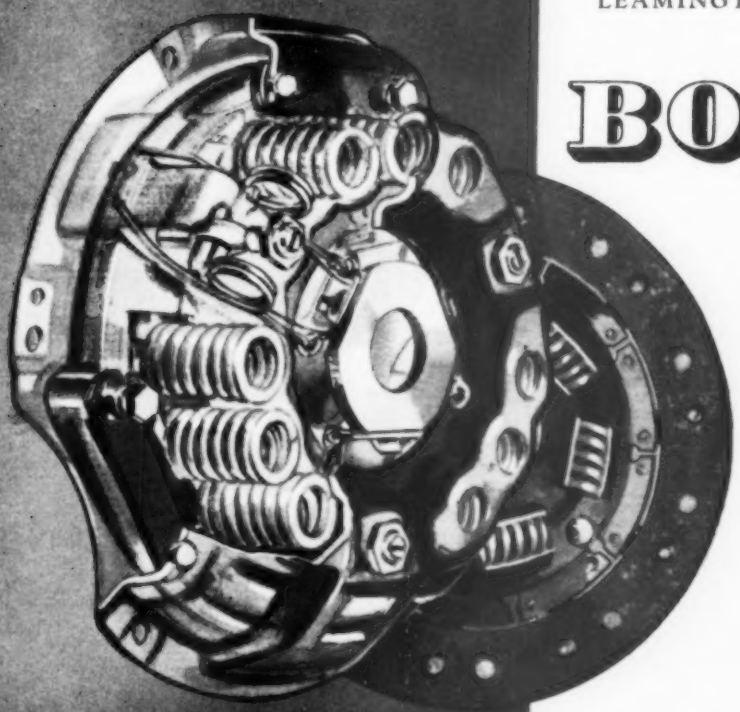
by virtue of their excellent performance, based upon sound design and accurate manufacture from the finest materials. There is a Borg & Beck clutch available to meet every requirement.

Above is shown one of the Borg & Beck 'A' type range of clutches. Below: A sectional view of the A. S. strap-drive clutch.

BORG & BECK COMPANY LIMITED
LEAMINGTON SPA, WARWICKSHIRE, ENGLAND



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LOCKHEED DISC BRAKES . . .

. . . made in different sizes, are now fitted as standard equipment to many of Britain's leading high-volume production luxury cars.

Their performance is well proved and every claim we have made for them has been more than substantiated.

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Either on all wheels or in combination with disc brakes, they rank as the most efficient drum brakes for all sizes of car.

Lockheed complete braking systems can be supplied with power servo assistance and, when desirable, also with the pressure limiting valve.

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As in all Thompson joints, efficient protection against the ingress of grit and moisture is provided by a positively sealed rubber boot.

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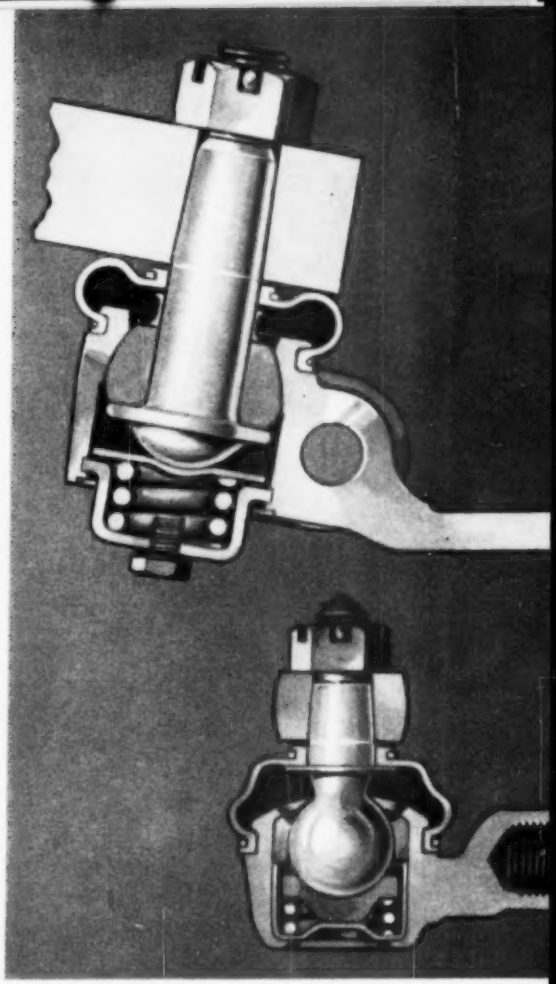

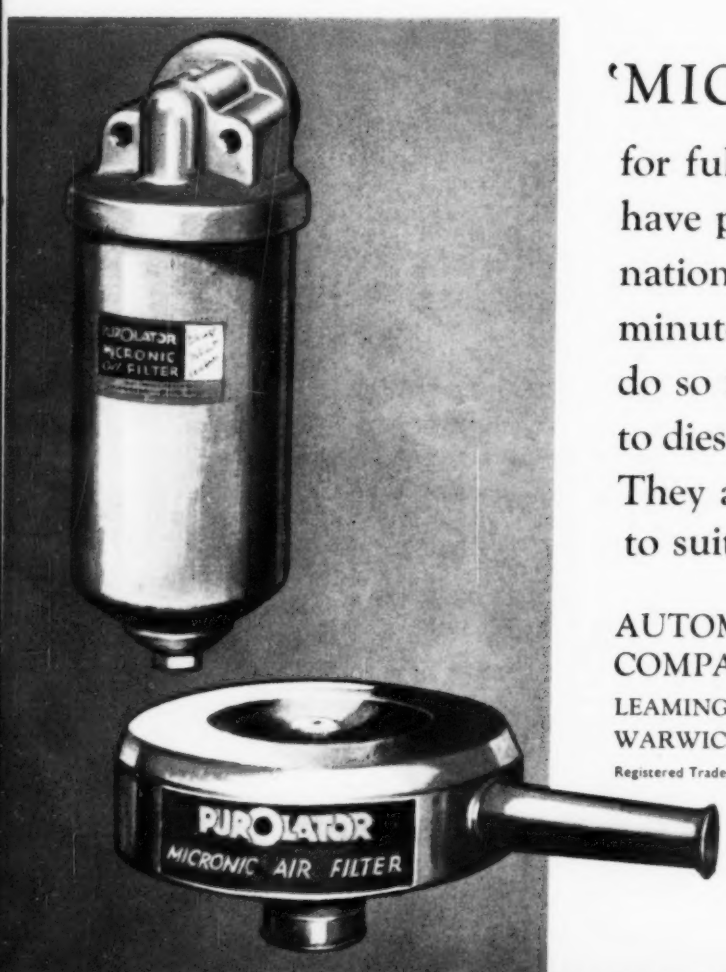

'MICRONIC' FILTERS

for full-flow oil and fuel filtration have proved their efficiency on a nation-wide scale, arresting the minute abrasive particles which can do so much damage to engines and to diesel injectors.
They are available in sizes to suit every engine.

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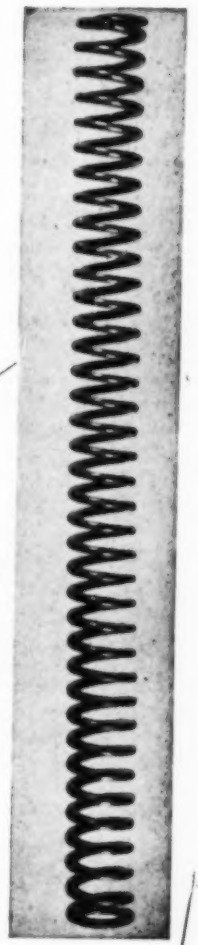
Vital links in controlled movement

A body needs muscles to control movement in very much the same way as a mechanism needs springs. These vital links take the stress and strain of every day rigorous use — nature provides the muscles . . . SALTER provides the springs. Two centuries of experience and development in the manufacture of springs of every type have enabled us to keep ahead of the ever-changing requirements of industry.

By courtesy of Webley & Scott Ltd.



The applications for SALTER springs are wide and varied — from heavy machinery to finely balanced instruments.

For springs with the highest reputation and top performance specify SALTER all-action springs.

SALTER ESTABLISHED 1760

GEO. SALTER & CO. LTD.

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This is Tecalemit isn't it?

TECALEMIT—LUBRICATION, of course. You see the Tecalemit target and arrow sign and take the car in for lubrication service. Grease pumps, pipes, lifts, oil dispensers, air compressors—everything's Tecalemit, right down to the grease nipples. So it's simple: Tecalemit stands for Lubrication.

But Tecalemit stands for filtration
In spite of high compressions, greater loadings and higher speeds, modern car engine bearings can tolerate almost anything—anything except foreign bodies in their oil. Thus the Tec-element: an oil filter element of astonishing efficiency. Most leading British engine manufacturers fit Tecalemit oil filters and so recommend Tec-elements as replacements. Sound advice!

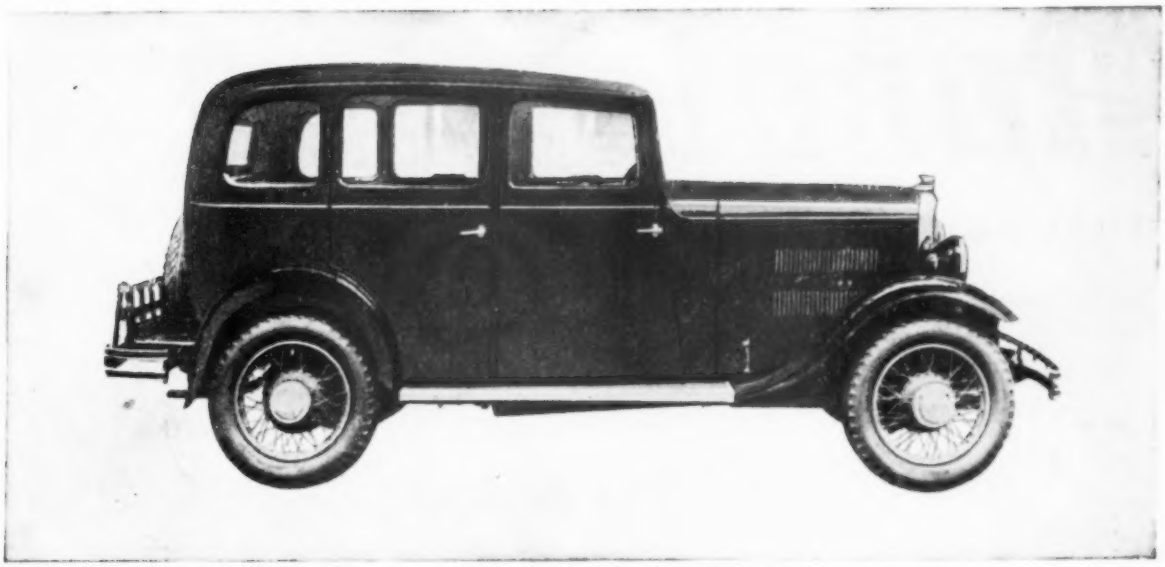
But Tecalemit make precision nylon piping too
Nylon piping for automotive uses was once merely a Good Idea. If only you could use it, it would be cheap, vibration resistant, strong, supple, chemically inert and so on. But how could it be produced to precision limits? Tecalemit found the answer—a resounding and exclusive technical triumph. Nowadays such great names as Austin, Aston-Martin, Ford, Jaguar and Rover use a great deal of Tecalemit extruded nylon piping for fuel lines and vent pipes.

But Tecalemit are famous for oil firing
Oil firing: it takes you out of the automotive field and into the brickworks and kilns. Much tidier brickworks, of course: no heaps of coal and slag. Just pipe runs, control panels, high efficiency and low cost. Oil firing is becoming a major industry in itself—and Tecalemit one of its most prominent names.

But Tecalemit make a thousand other things
Grease guns, power pumps, hose reels, lifts, sprayers, washing units . . . automatic and multiple lubricating systems for machinery and vehicle chassis . . . air cleaners, breathers and ribbon elements (finest air filtration at lowest cost) . . . in fact, an amazing number of things that help keep industrial and automotive machinery washed, pressured, connected, controlled, raised, lowered, filtered.
Oh yes—and lubricated. For of course Tecalemit stands for lubrication.

TECALEMIT **the Authority on Lubrication**

Tecalemit Limited · Plymouth · Devon



You learn a lot in 28 years . . .

Reproduced by courtesy of the Rover Car Company

- There were no short cuts between the motor car of twenty-eight years ago and the motor car of today. Practical advances were won hard—by sheer experience. Always, *it's experience that counts.*
- In the plastics world the same holds true. Today's problems are best solved by those whose know-how has the longest roots. EKCO PLASTICS began over a quarter-century ago and has a long association with the motor industry. We too have learned a lot in 28 years . . .
- *Our experienced designers and engineers will willingly discuss your plastics problems—entirely without obligation.*

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anti-scuffing products are

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Rocol Anti-scuffing Products provide the best means of applying Molybdenum Disulphide — the most advanced lubricant known to engineering science — to all rubbing surfaces.

ANTI-SCUFFING PASTE. In paste form for general purpose use.

ANTI-SCUFFING OIL. For reinforcement of all lubricating oils.

ANTI-SCUFFING SPRAY. In aerosol form — containing bonding resin.

Our Technical Information Service will provide any further information you may require about these and other Rocol Molybdenised Lubricants.

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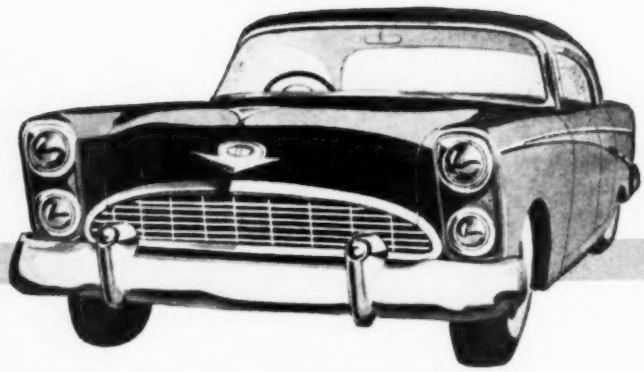

STAINLESS STEEL never shows its age

The motor industry 'builds' on the strength and stability of Lee's "Trubrite" Stainless Steel . . . impervious to corrosion, and possessing maximum stability. For gleaming body trim—Stainless Steel has no equal. Resistant to rust, dents and scratches, its time-proof brilliance needs only soap-and-water care—and maintains vehicle value to the highest degree.

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impact wrench
SIZE 24

Basically designed as a Nut Setting Tool, this Impact Wrench may be effectively used with the available attachments for screwdriving, tapping, drilling, grinding, wire-brushing or sanding.

Extra strong in design and construction this tool incorporates longer normal working life with minimum maintenance.

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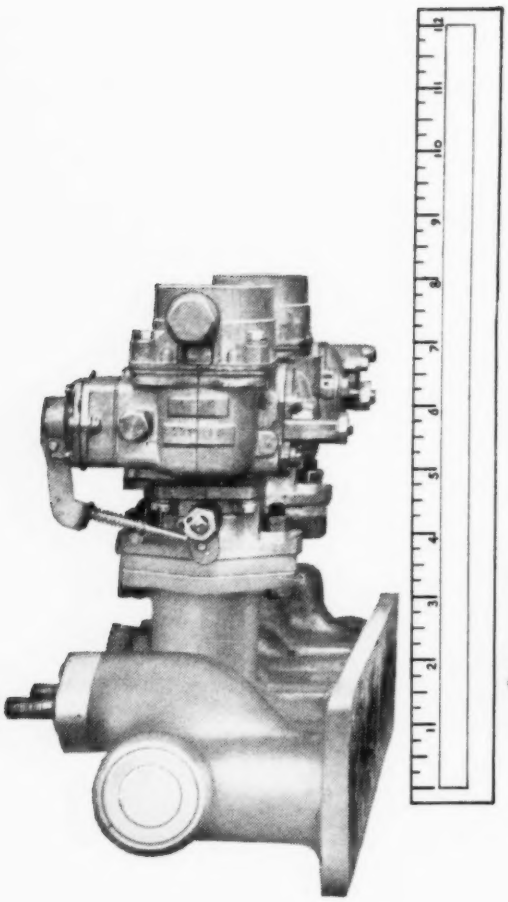
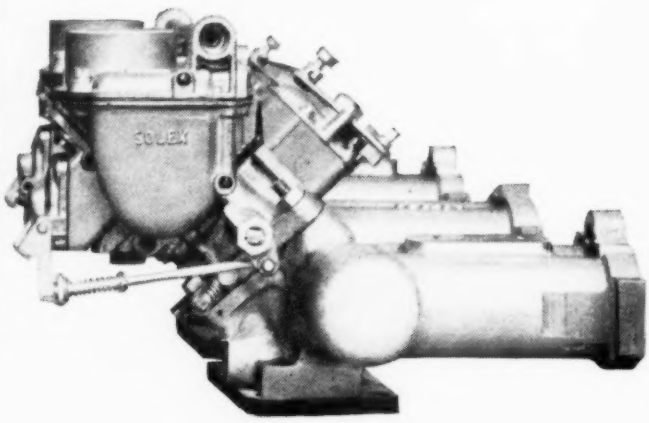


SOLEX...



solve the space problem!

Just look at the height saved by this very latest advance in Solex carburation—the Solex B32 IH and PIH models. These new integral semi-downdraught carburettors, of completely new design—combine the advantages of the Solex downdraught and horizontal models, and occupy a minimum of space.

Two B32 PIH carburettors are fitted to the New Standard Vanguard Luxury Six.

THE NEW SOLEX B32 IH and PIH MODELS

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Leaders in Carburation

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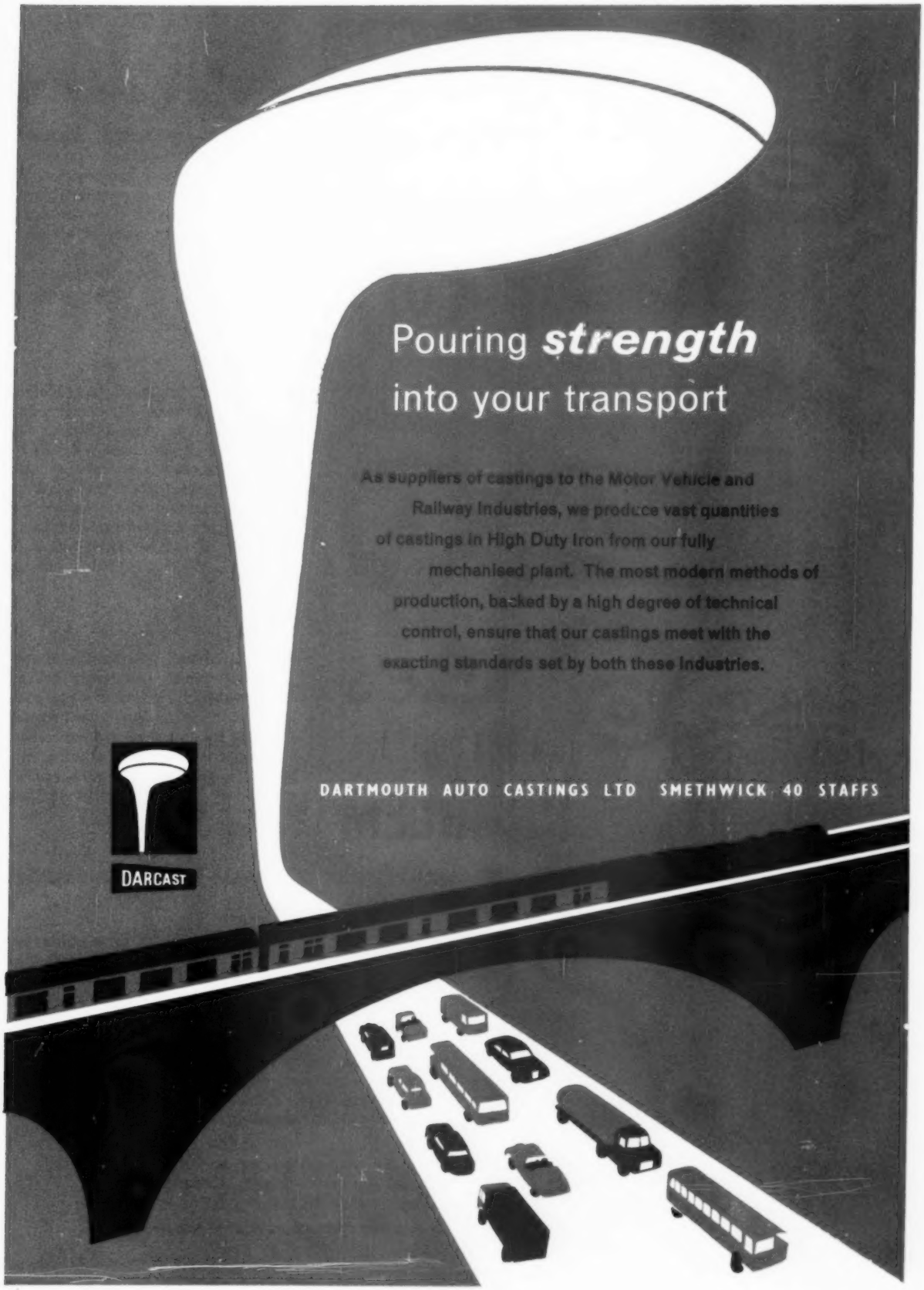
Pouring strength
into your transport
As suppliers of castings to the Motor Vehicle and Railway Industries, we produce vast quantities of castings in High Duty Iron from our fully mechanised plant. The most modern methods of production, backed by a high degree of technical control, ensure that our castings meet with the exacting standards set by both these Industries.
DARTMOUTH AUTO CASTINGS LTD SMETHWICK 40 STAFFS
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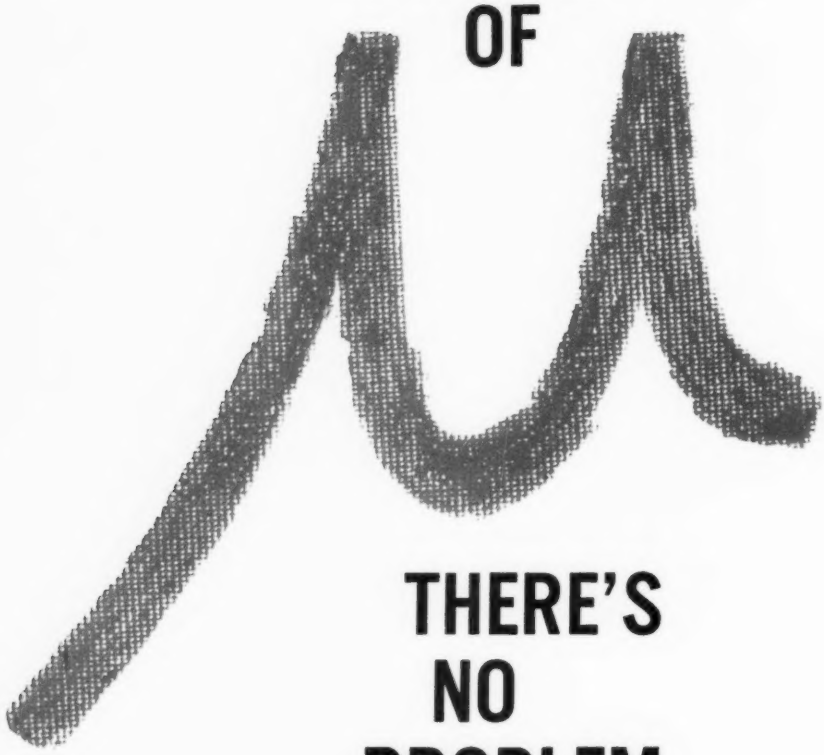


THERE'S NO PROBLEM

μ has many meanings. One of the most mysterious things it symbolises is friction. No-one knows exactly what friction is; but you know some of the problems and possibilities it presents.

Ferodo is well equipped to find answers to the problems, and ways of exploiting the possibilities.

Think of our background: it includes every aspect of friction and friction materials for brakes and clutches. We manufacture every established type of friction material, from the most conventional to sintered metals and cermets.

Better still, we devote an unusually large proportion of effort, equipment and money to our research laboratories—incomparably the finest of their kind in the world.

And all these production and research resources can be put to work for you.

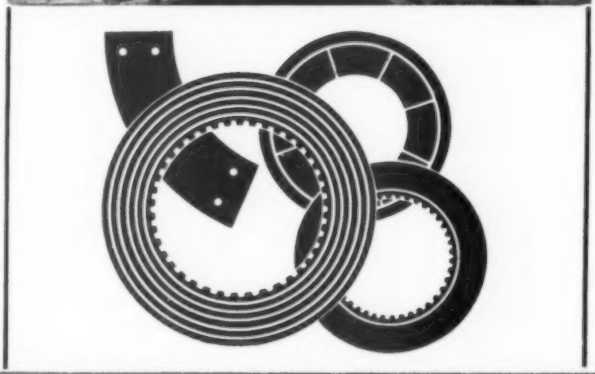
FOR EXAMPLE . . .

Automatic Transmissions commonly depend on a multiplicity of drive and control systems, each with its own special friction problems demanding materials with individual characteristics. So far, these demands have been met by Ferodo materials of one sort or another. But perhaps you have a special problem?

Earth-Moving Machinery poses enormous problems in terms of wear resistance and high-temperature stability of friction materials. Ferodo sintered metal facings and Ferodo cermets are providing some striking solutions — and probably any problem inherent in automotive clutch designs for heavy duty can be met by them. Is this your problem?

Friction Materials themselves may suggest simplified answers to apparently complicated questions. We believe that many brake, clutch and transmission problems could be solved more quickly by designing round the friction materials available. Would you like to consult us at the design stage?

Borg Warner Ltd



Remember — only Ferodo manufacture a complete range of friction materials: and therefore only Ferodo can promise completely unbiased advice on friction problems. You are cordially invited to bring us such problems.

ask Ferodo First!

FERODO FRICTION MATERIALS

Ferodo Limited · Chapel-en-le-Frith
A Member of the Turner & Newall Organisation

Leyland

POWER PLUS Series

rely on LARGE PRESSURE DIE CASTINGS by

The new range of Leyland vehicles takes advantage of the reduced machining costs and better weight ratios available with aluminium castings from our large pressure die casting machines. Precision castings in quantity up to maximum area of 265 sq. ins. with weights of 110 lb. in zinc or 44 lb. in aluminium alloy, are now available to industry

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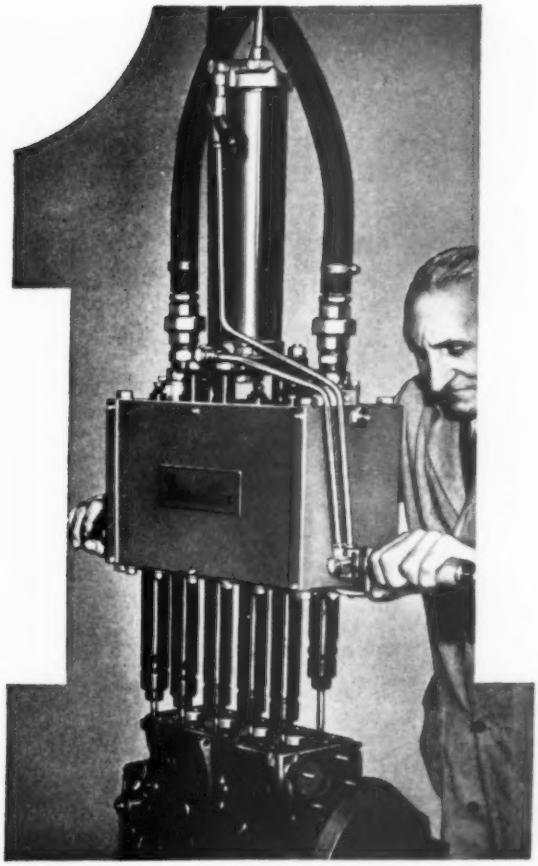

1st with a multiple studrunner

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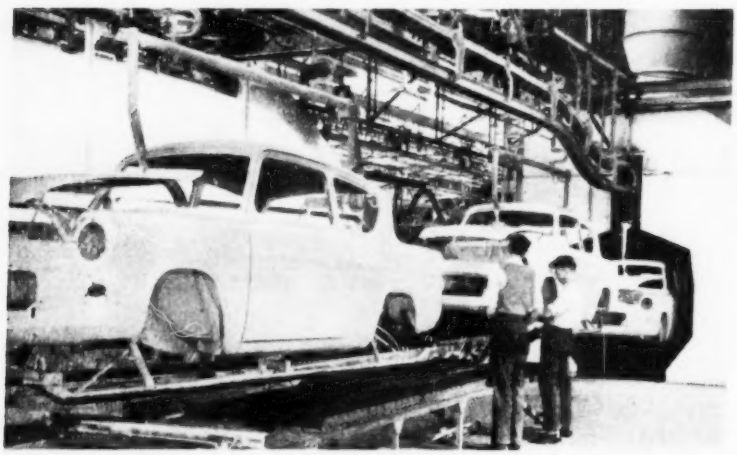

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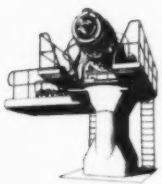

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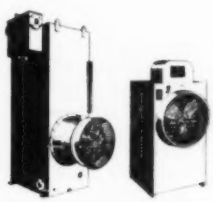

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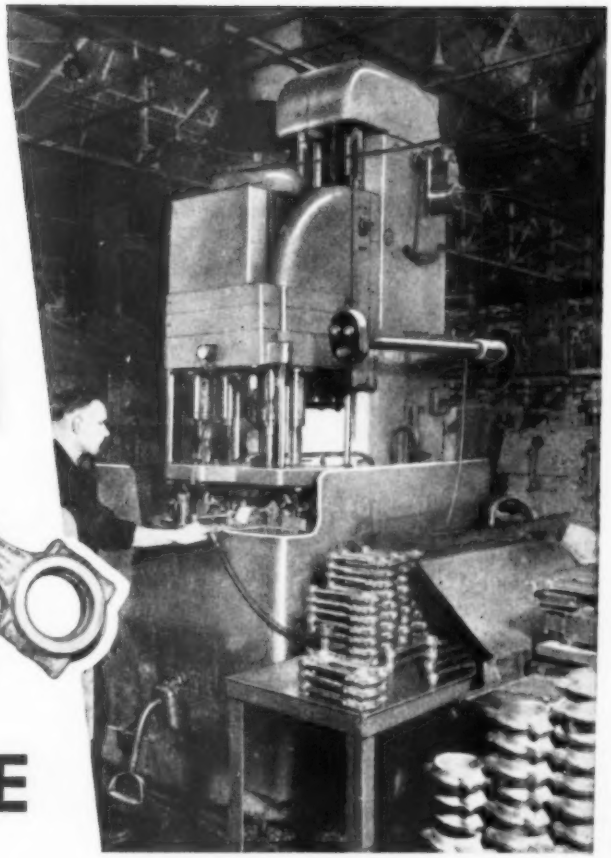

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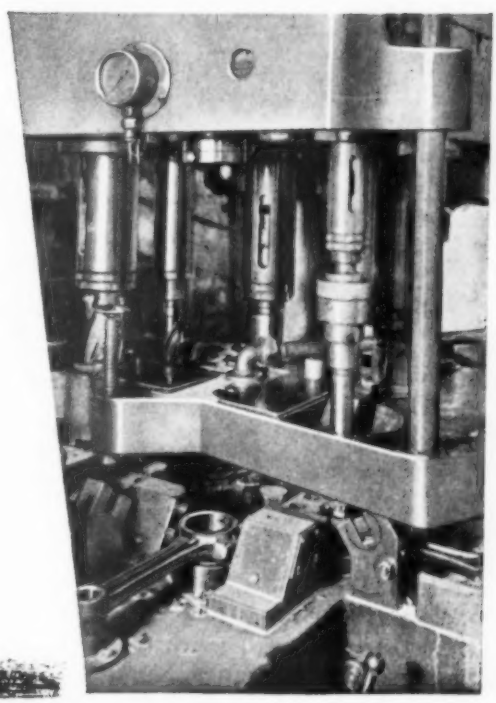

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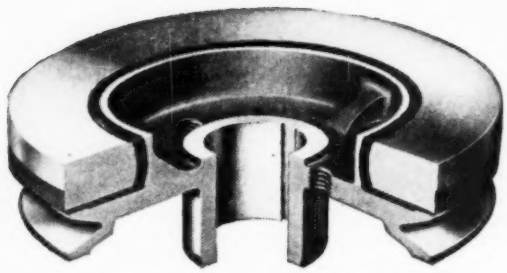

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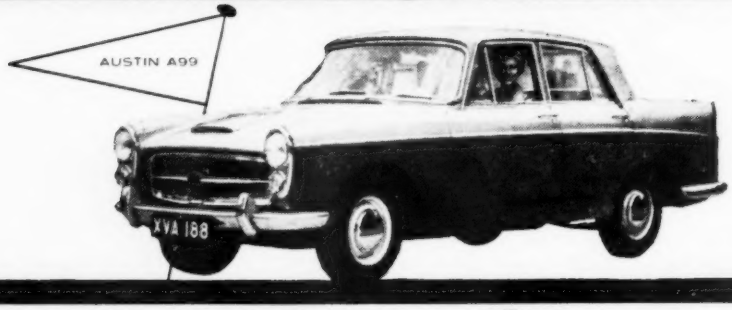

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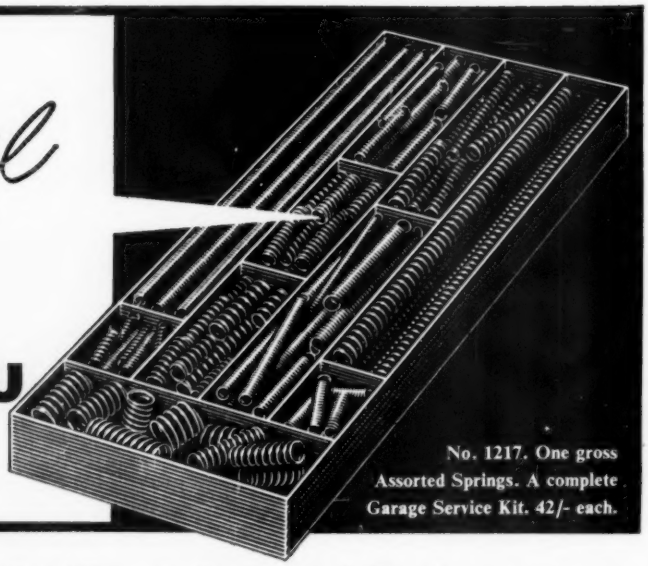

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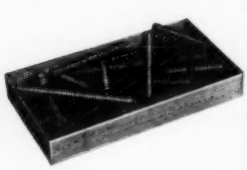

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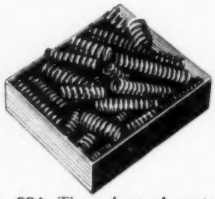

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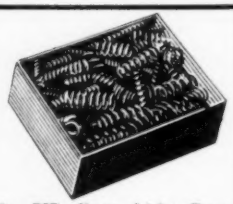

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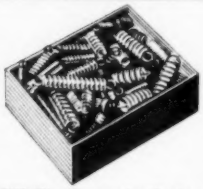

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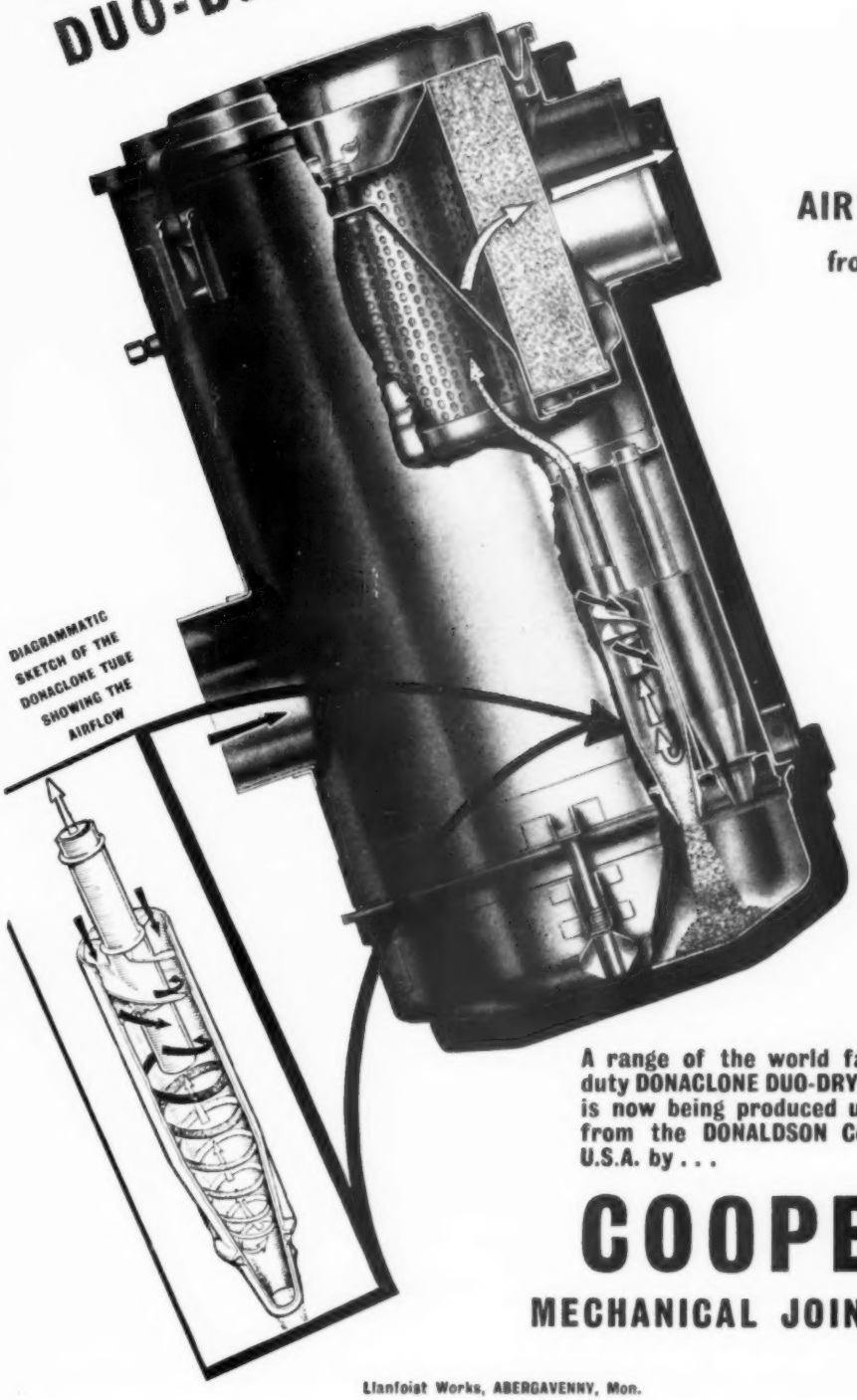

DIAGRAMMATIC SKETCH OF THE DONACLONE TUBE SHOWING THE AIRFLOW

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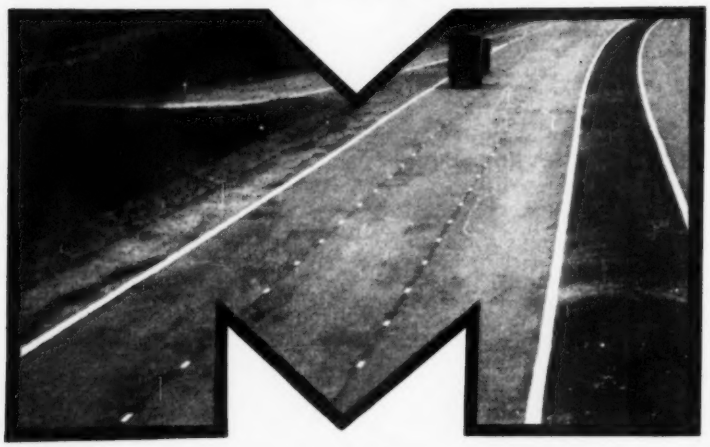

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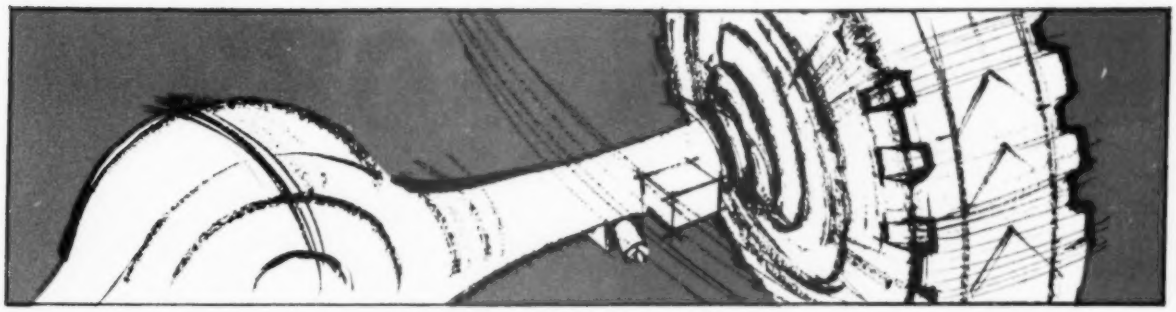
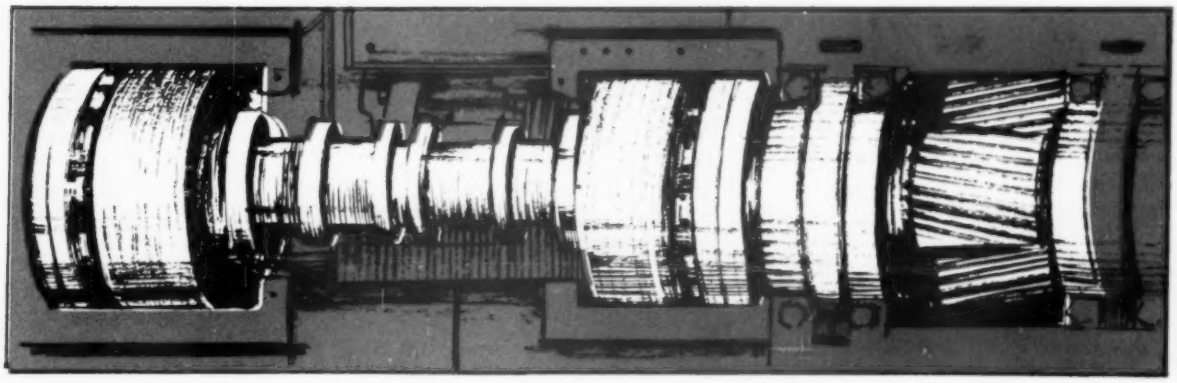


consult R&M bearing experts

when at the prototype stage



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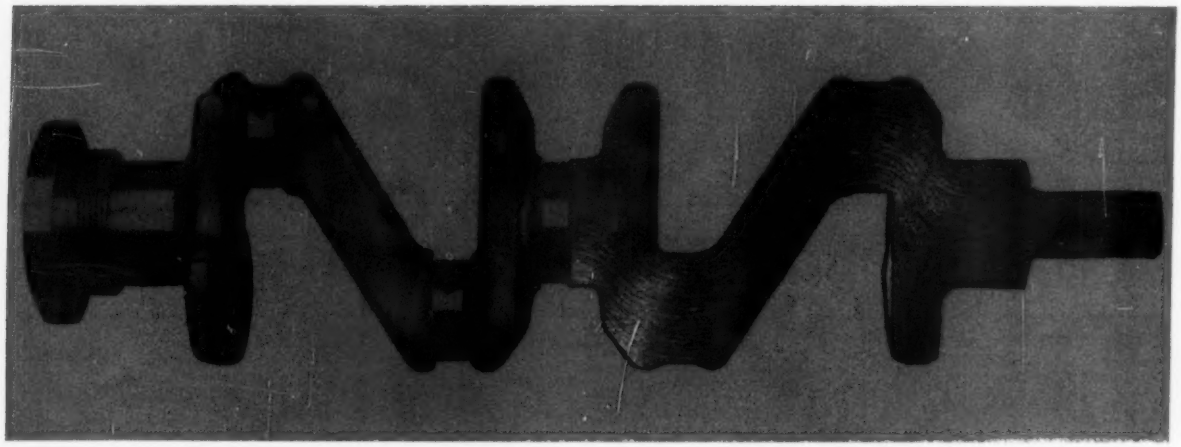

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*The photograph of a sectioned crankshaft clearly shows how the grain flow of the metal follows the contour of the forging thereby ensuring maximum toughness and resistance to fatigue.

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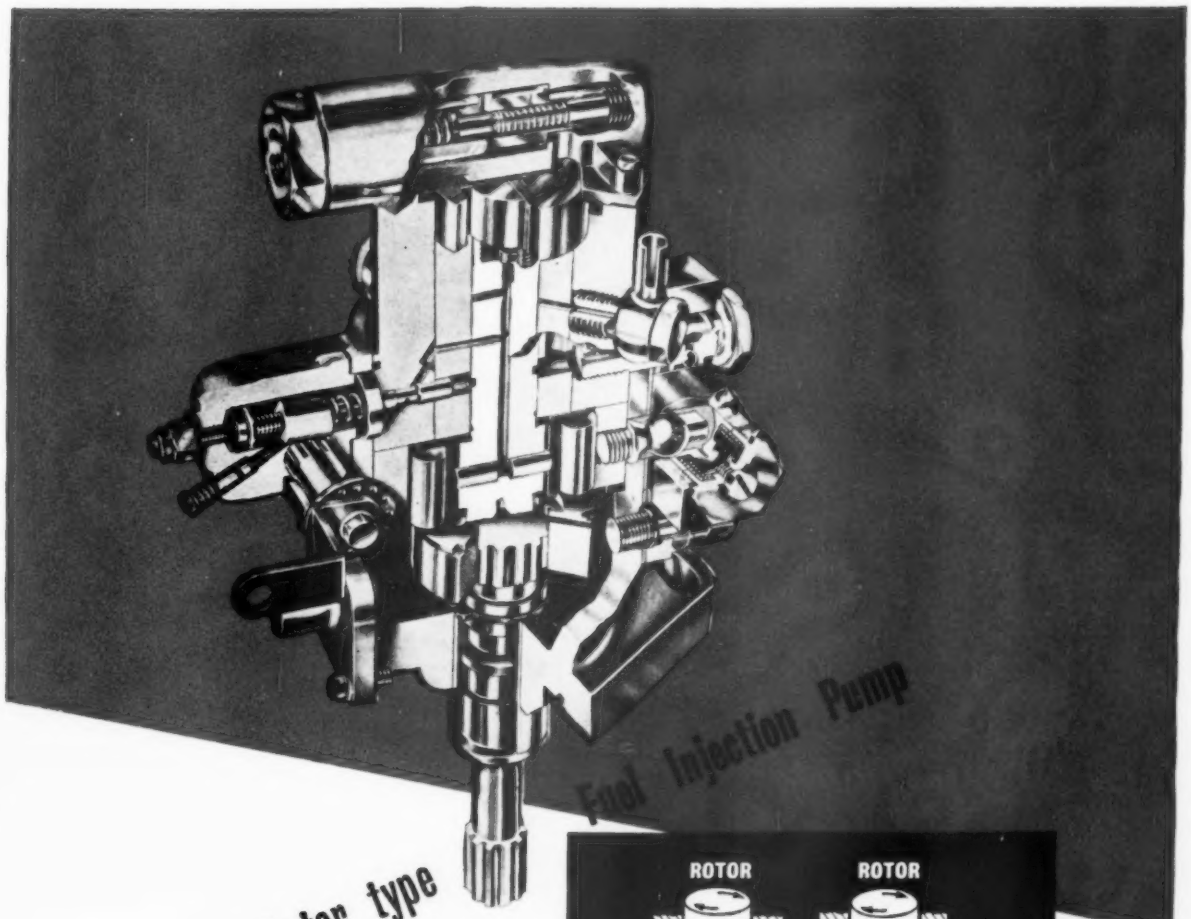
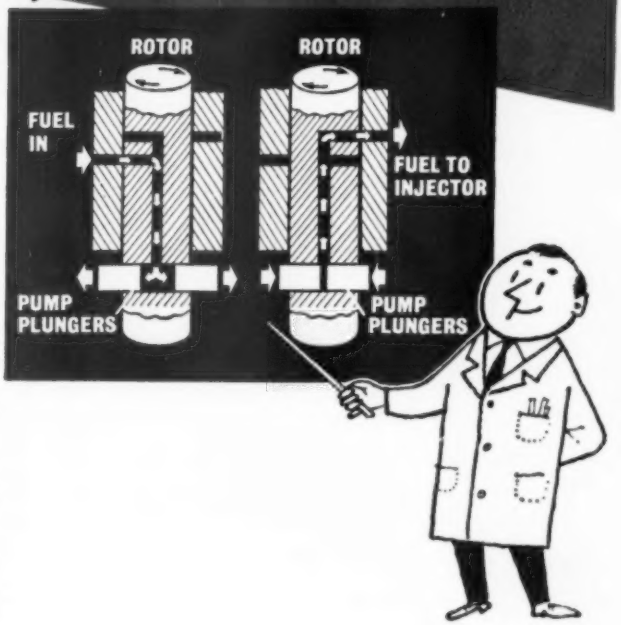


The Distributor type Fuel Injection Pump



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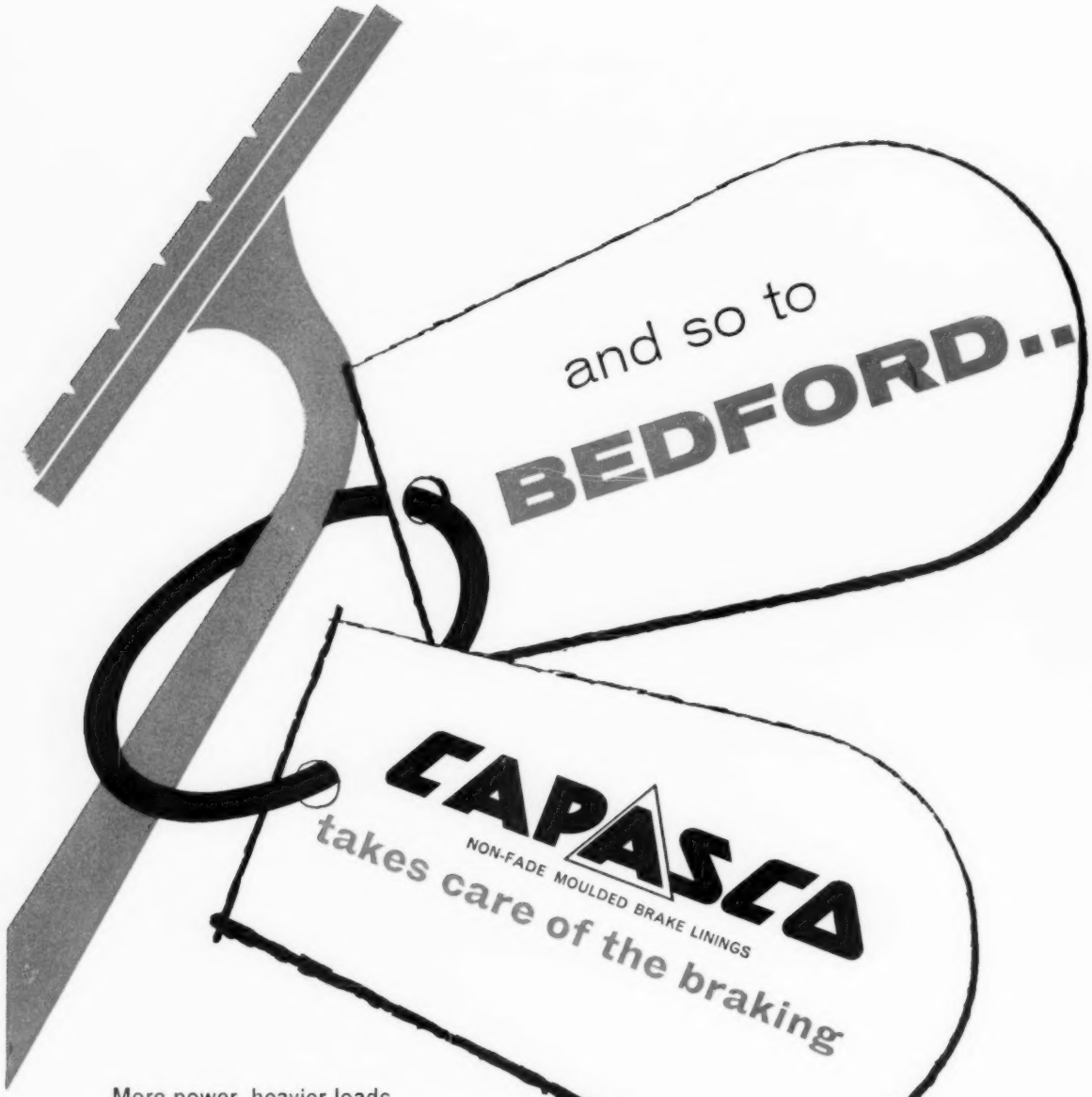

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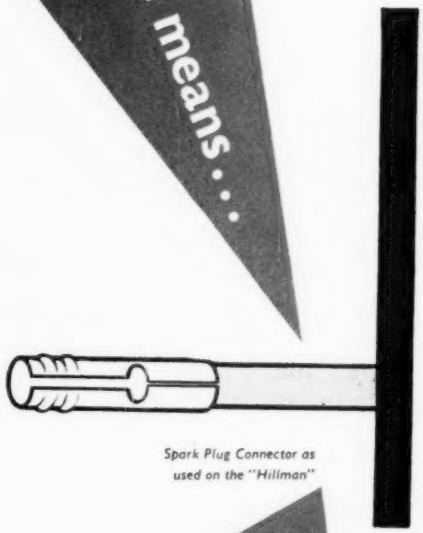

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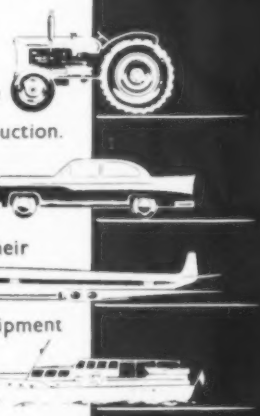

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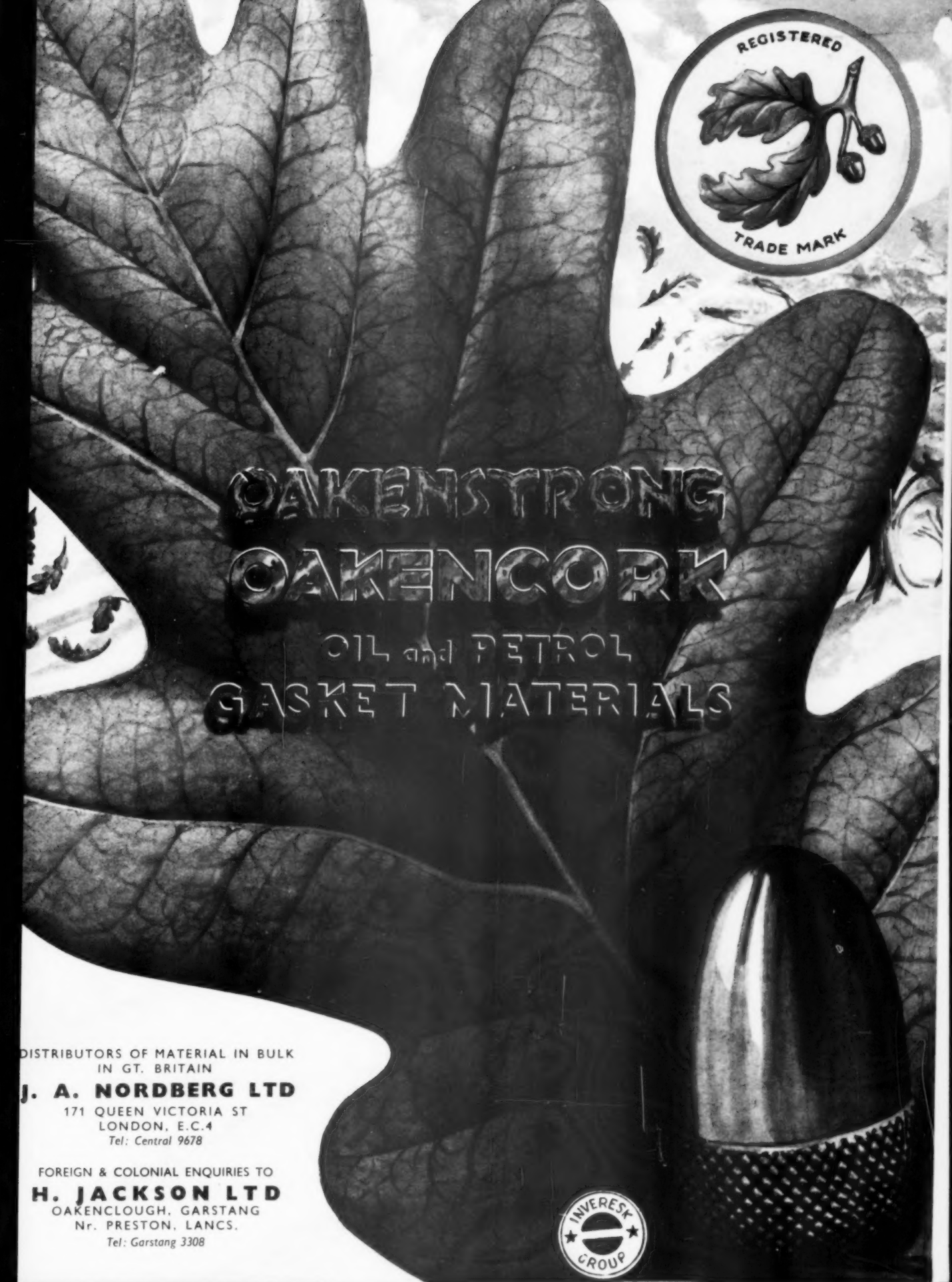

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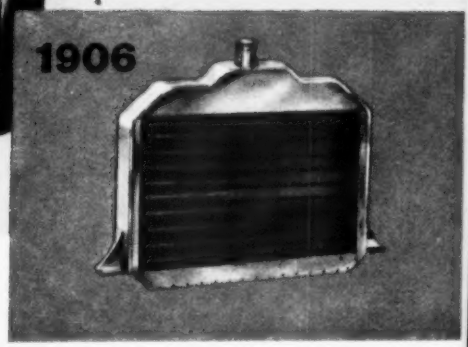

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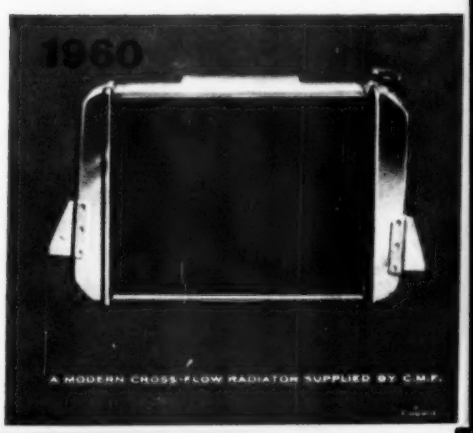
Call in C.M.F ... who have been in continuous business as radiator makers since 1902. The resulting experience has enabled C.M.F. to amass a total of design and production 'know-how' which is unique ... and more to the point ... is at the disposal of the automobile designer at any time.



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A recent RTB development is the 'ARTBRITE' series of P.V.C. coated sheets, available in various decorative finishes, glossy and matt, plain and patterned. Normally based on RTB galvanized sheets, 'Artbrite' sheets are resistant to abrasion and to a great many chemicals; further, they have extraordinary 'workability', being suitable for practically every operation that the RTB steel sheets will stand. 'Artbrite' sheets are weather-resistant.

Richard Thomas & Baldwins (Sales) Limited

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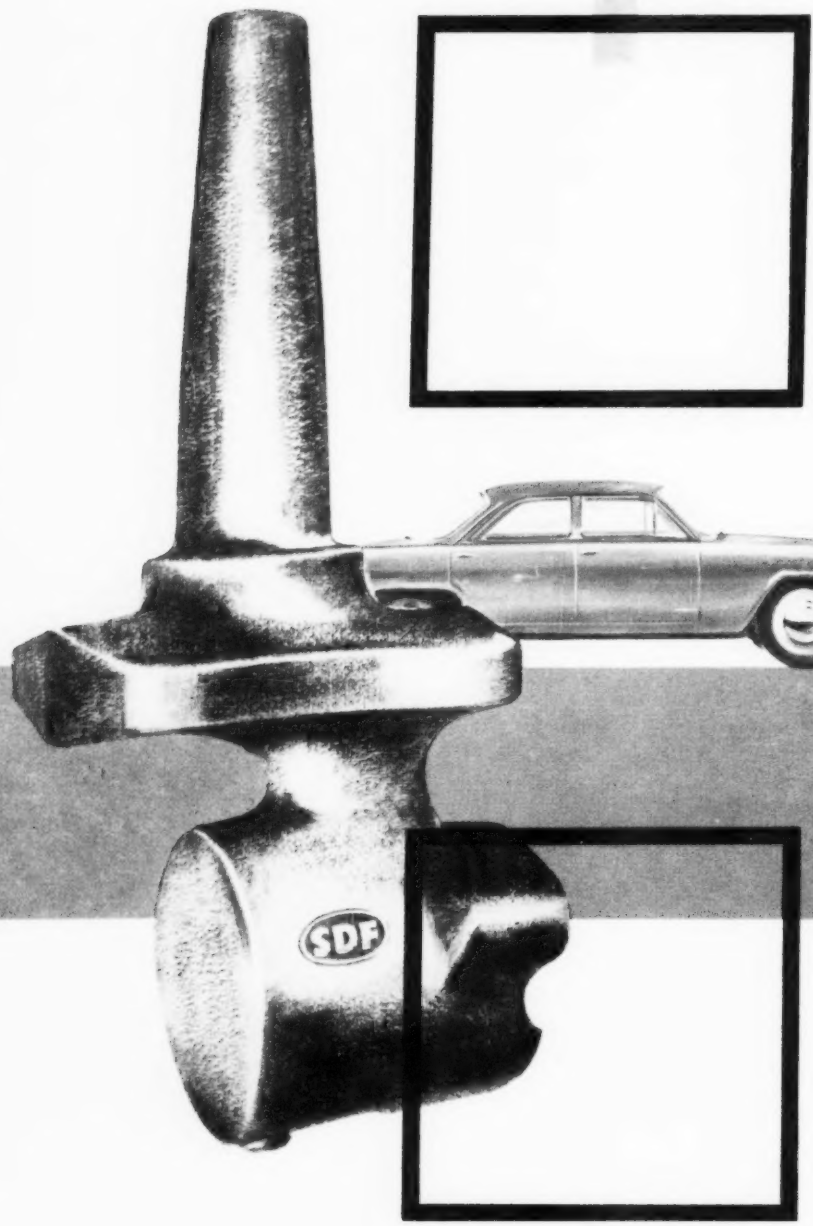
RTB



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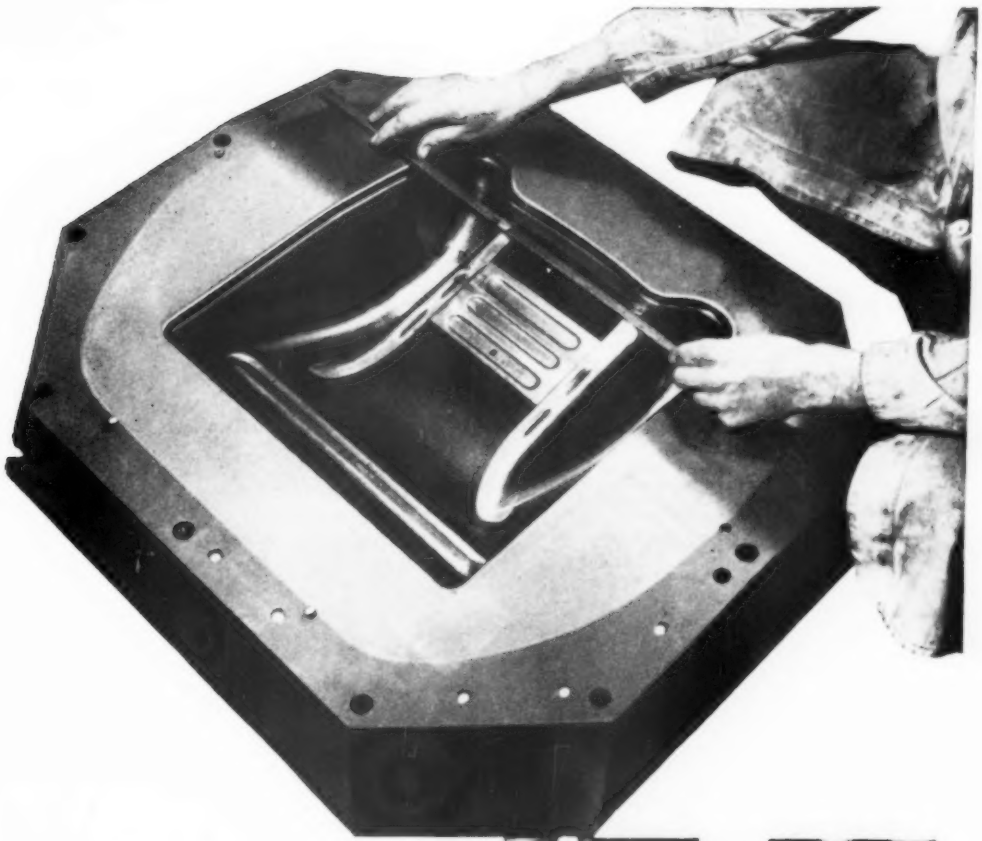

Advanced Techniques

Engineers who habitually think in terms of advanced techniques know that epoxy resin dies offer savings in the cost of tools, whether for prototype, pre-production or short runs.
The punch and die shown are used by Ransomes Sims & Jefferies, Ltd. for pressing casings for one of their latest types of lawnmower. The final die and punch comprise low-cost cores faced with Araldite epoxy resin. This system provides press tools which are easily and quickly made, and cost less, so that Araldite tools show great economies in comparison with traditional metal equivalents. Production runs exceeding 8,000 pressings have been achieved with dies made from these materials. Modifications are simple and can be conveniently effected. May we send you our book "Araldite Resins for Tooling", which will give you design information?

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EPOXY RESINS

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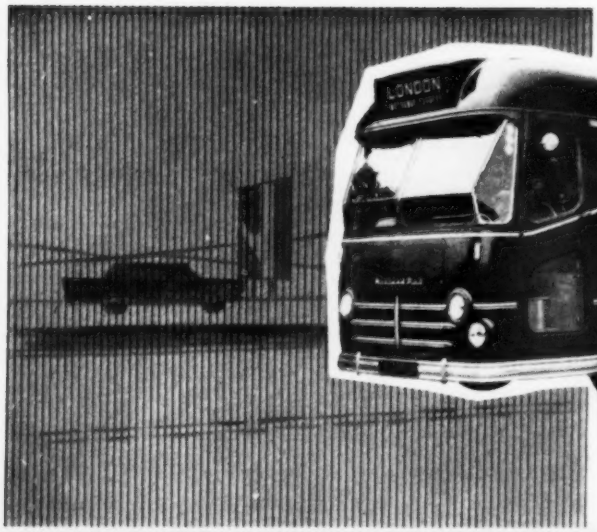
AP 584

On the Motorway



A completely new conception of public transport has been made possible by the London-Birmingham Motorway, with coaches cruising at speeds of 70-80 m.p.h. over its full length. These Midland Red Motorway Express Coaches, typifying this new era, are fitted with every modern device for safe, economical operation.

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Glacier Centrifugal Oil Filters, for Transport and Commercial Vehicle Engines ensure optimum oil cleanliness at minimum operational cost.

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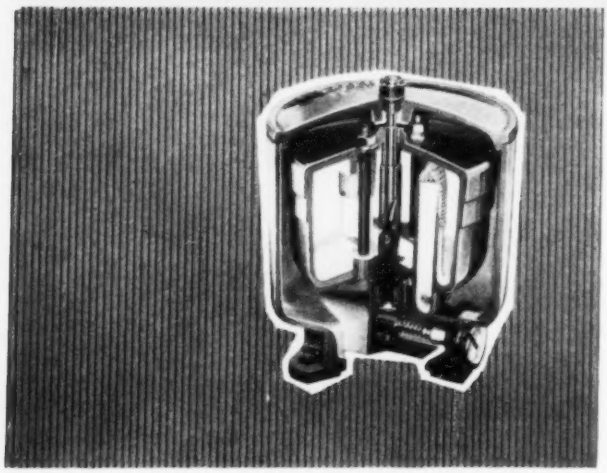

Compared with conventional filters, Glacier extractors have a number of advantages:-

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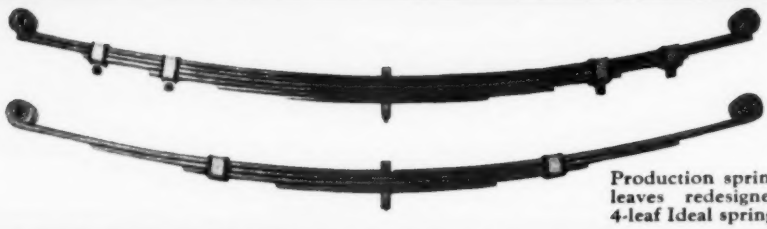
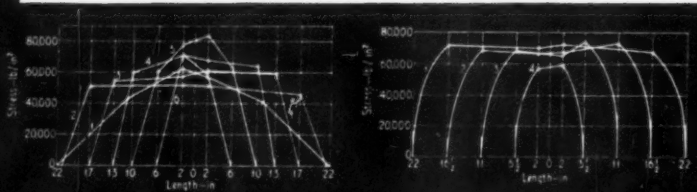
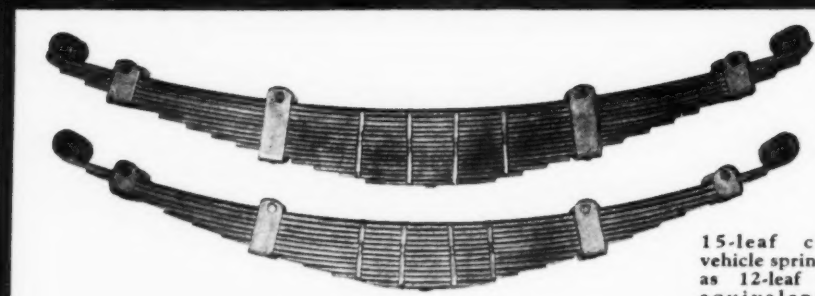
HOW TO SAVE SPRING WEIGHT WITHOUT INCREASING STRESS

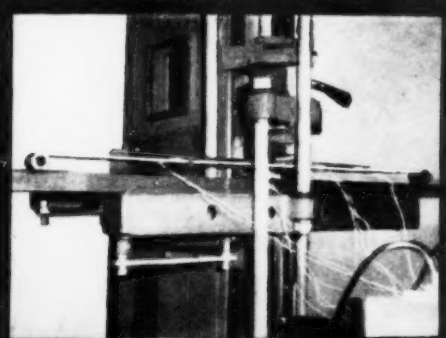


Production spring with 6 leaves redesigned as a 4-leaf Ideal spring.





15-leaf commercial vehicle spring redesigned as 12-leaf Featherlight equivalent without increase in maximum stress.



TWS
'featherlight'
IDEAL SPRING
(PATENTS PENDING)

TOLEDO WOODHEAD SPRINGS LIMITED
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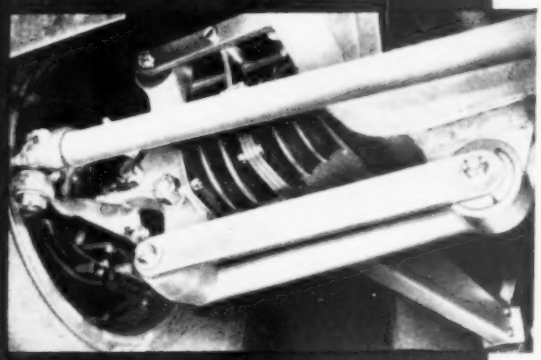
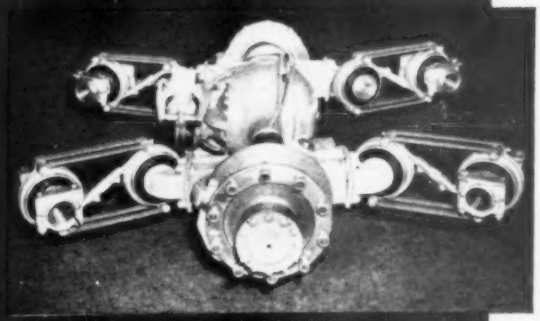
TWS 81

55 MILLION MILES ON SINGLE DECKERS

....now on Double-deckers: METALASTIK RUBBER SUSPENSION



Pioneers in the modernization of many important 'bus features, "Midland Red" have benefited by their 55-million-mile single-decker experience of Metalastik suspension, which they now incorporate in their double-deckers, the new B.M.M.O./D.9. shown above, and also in their C.M.5. Motorway-Express-Coach shown below at M.I.R.A., being tested up to 85 m.p.h.



It is a tribute to the sound principles underlying the Metalastik suspension system (two centre pictures) that the same basic design meets the requirements of these three widely differing services, resulting in economical operation, and a substantial increase in safety.

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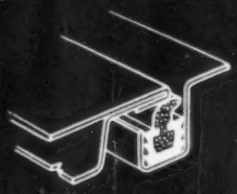

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CHANNEL SEAL

"SNAPPON" CT TYPE

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- ★ FOR PLAIN FLANGE
- ★ SUBSTANTIAL COST SAVER

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516,472	14,051/53
522,025	10,723/54
548,757	13,482/54
588,898	7,853/56
617,595	5,875/56
631,890	5,902/55
655,268	26,653/55
649,137	29,215/55
708,245	2,922/55
702,743	34,064/55
655,299	36,674/55
700,254	36,675/55
707,757	8,160/56
705,093	8,159/56
711,371	9,404/56
705,634	8,014/56
27,756/52	9,177/56
28,547/52	5,875/56

PATENTS AND PATENTS PENDING IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD ALSO COVERED BY REGISTERED DESIGNS

SPLIT TUBE	DRAFTEX TF	SNAPPON TS.MS.	SNAPPON ME	SNAPPON CT TS.AR	SNAPPON CT TT.AR	SNAPPON CT LS.MS

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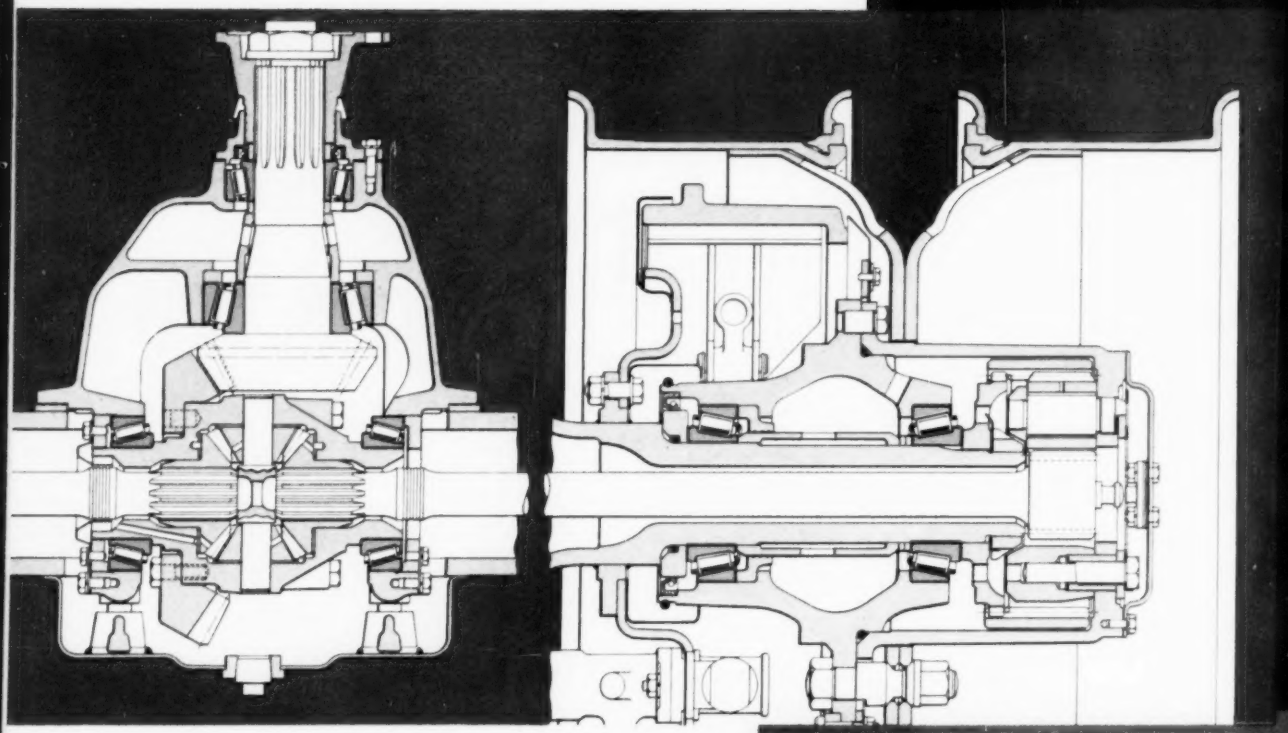

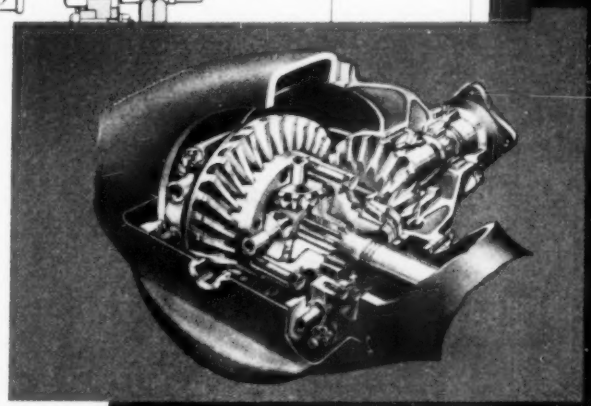

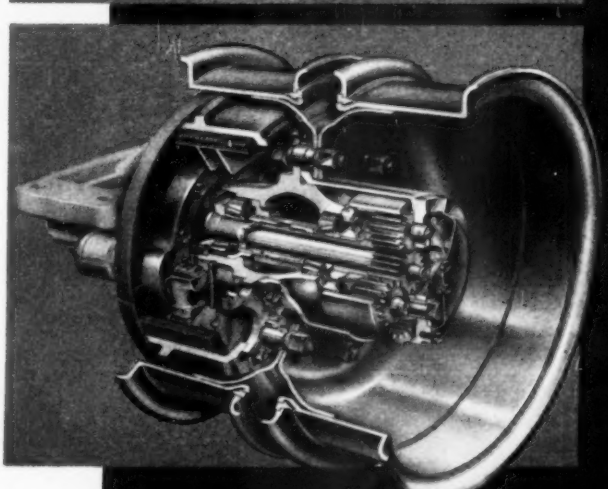

Albion 7-ton double-reduction axle

This axle is fitted to the 'Chieftain' and 'Victor' commercial and passenger vehicles made by Albion Motors of Scotstoun, and to the Leyland 'Comet'.

The drawings and photos show the construction. The right-angle drive gives only part of the reduction, permitting the use of a large pinion and a comparatively small crown wheel with low tooth loading.

Each half shaft has at its outer end a pinion engaging bushed planet pinions running on pins mounted in the planet carrier attached to the hub driving flange.

The internal wheel is neatly held against rotation by engagement with a toothed flange splined to the axle casing and permitting some degree of 'float'.

The mounting of the Timken bearings is self-explanatory, with the customary screwed rings for the differential bearings and selected spacers for the pinion bearing preload and for the wheel bearing adjustment.

British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Brazil, Canada, France and U.S.A.

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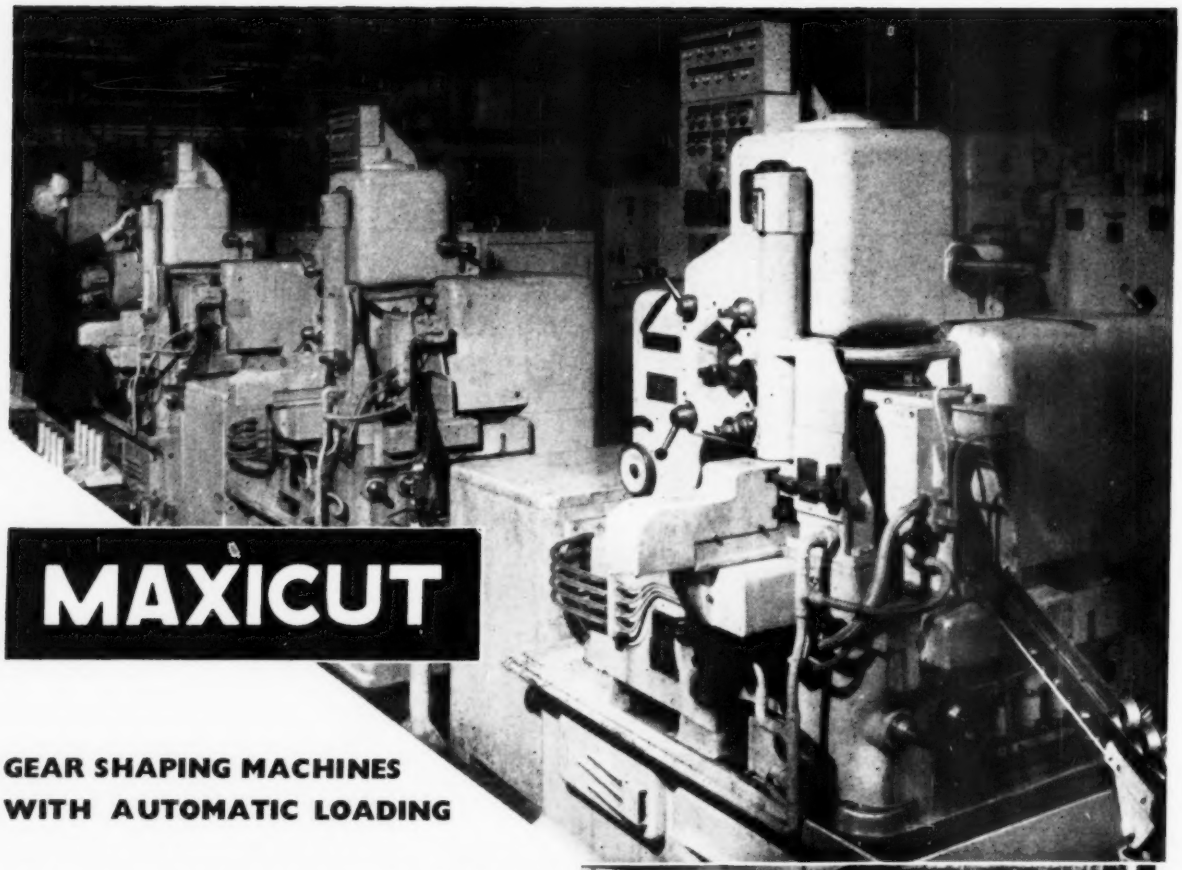
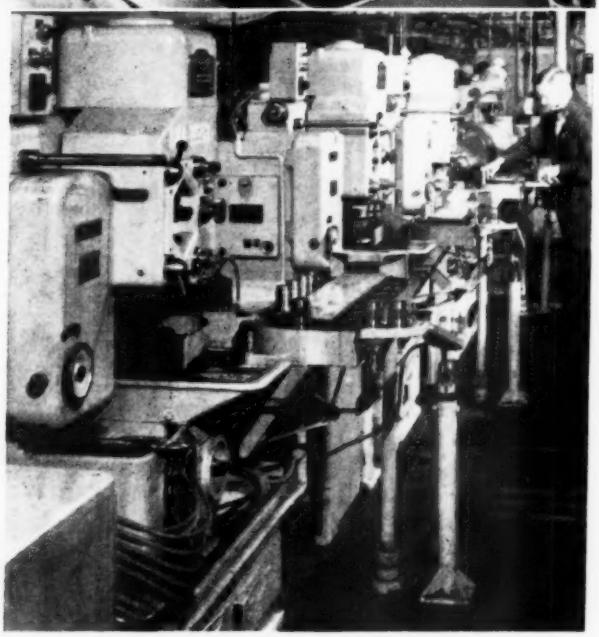


MAXICUT

GEAR SHAPING MACHINES WITH AUTOMATIC LOADING

for mass production of automobile gears

These illustrations show two lines of Drummond No. 2A Maxicut Gear Shapers at the Austin Motor Co. Ltd., Birmingham. Machines in the top view are equipped with magazine loading and in the bottom illustration swinging arm type loaders are fitted.



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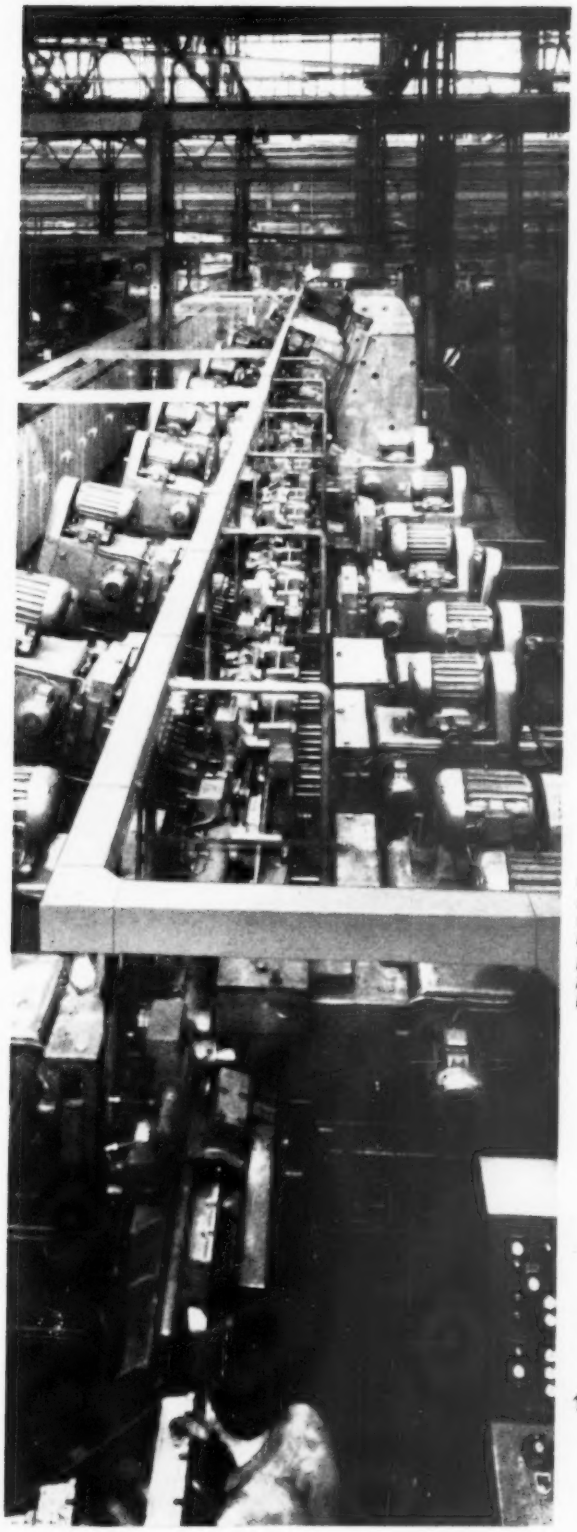

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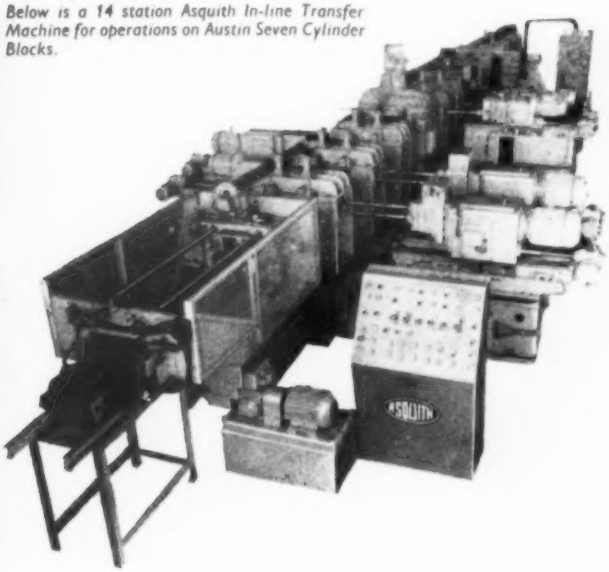
On the left is an Asquith 30 working station In-line Transfer Machine for operations on 5 types of cylinder heads at Ford Motor Company Ltd., Dagenham.

Below is a 14 station Asquith In-line Transfer Machine for operations on Austin Seven Cylinder Blocks.



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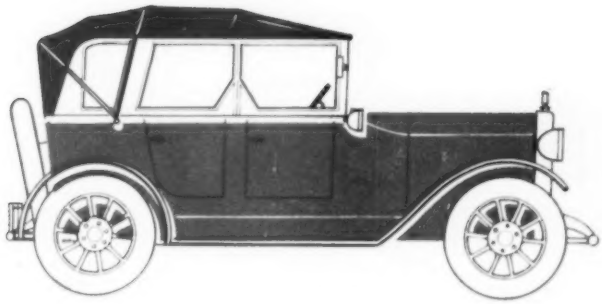

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Harrisflex controlled flexible bearings are being used for an ever increasing range of applications with new motor vehicles where either space or weight restrictions are involved. In addition these units offer advantages in their ease of assembly on production lines.

For further information concerning these products please ask for the appropriate technical literature.

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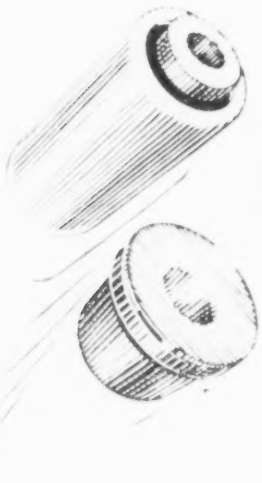

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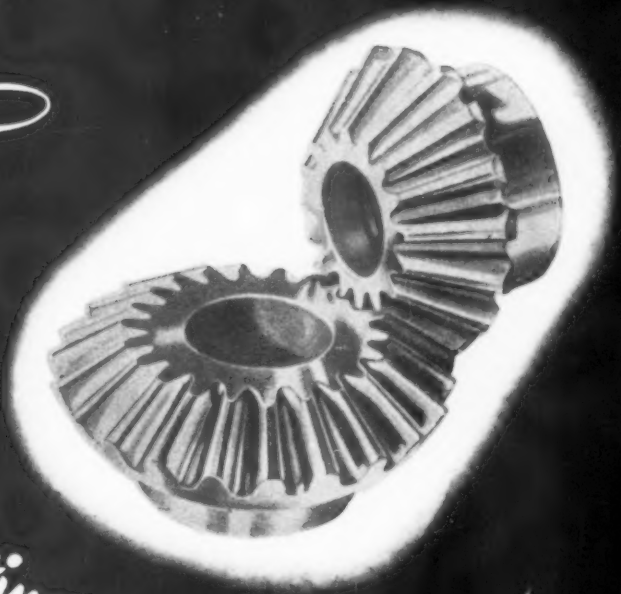

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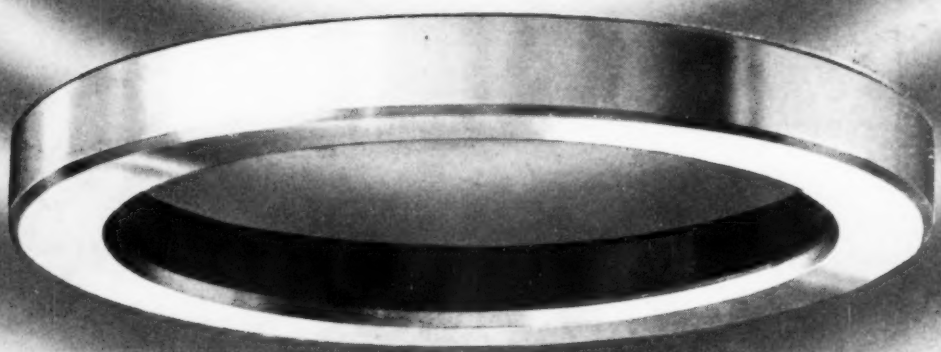

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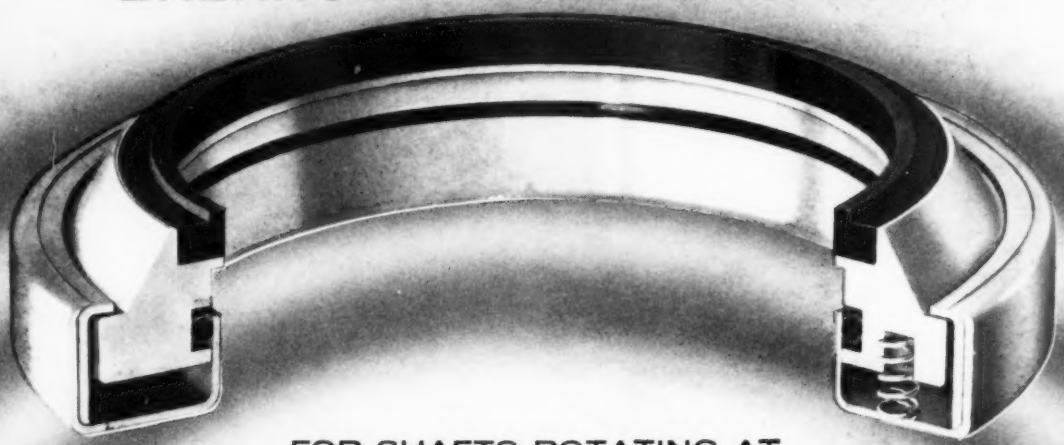

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HIGH SPEEDS COUPLED WITH
HIGH FLUID TEMPERATURES
AND PRESSURES

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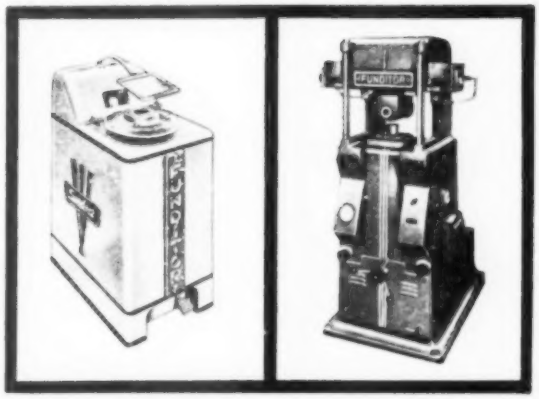

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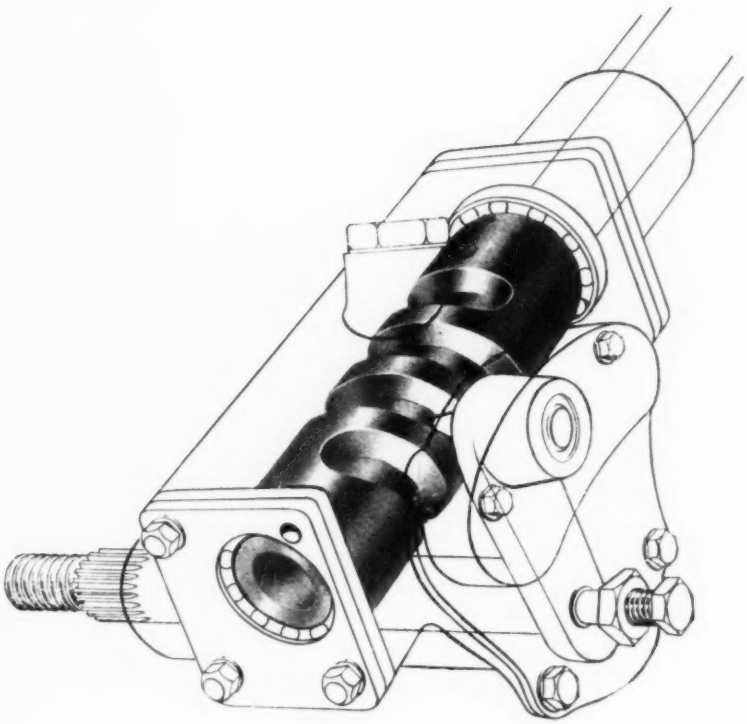

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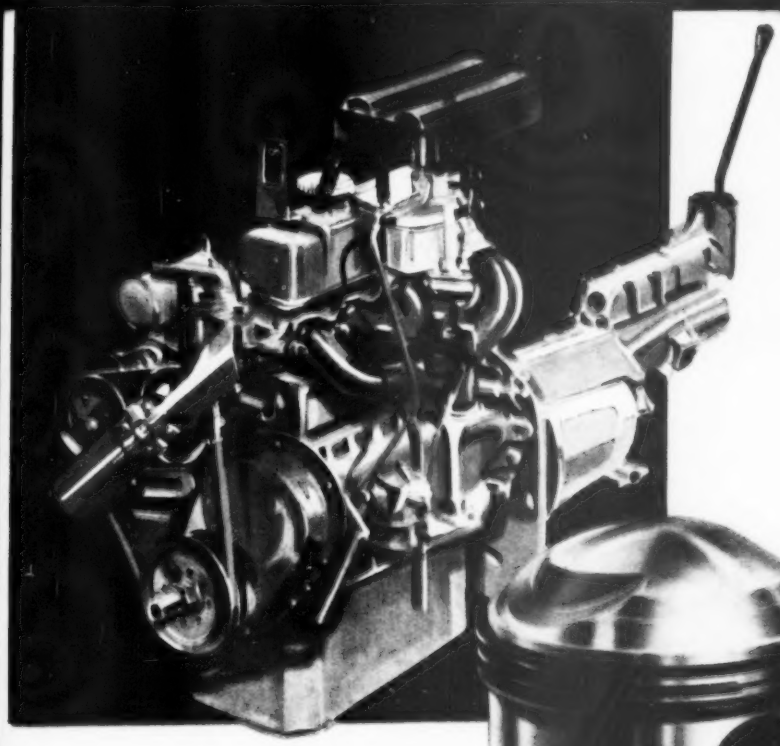

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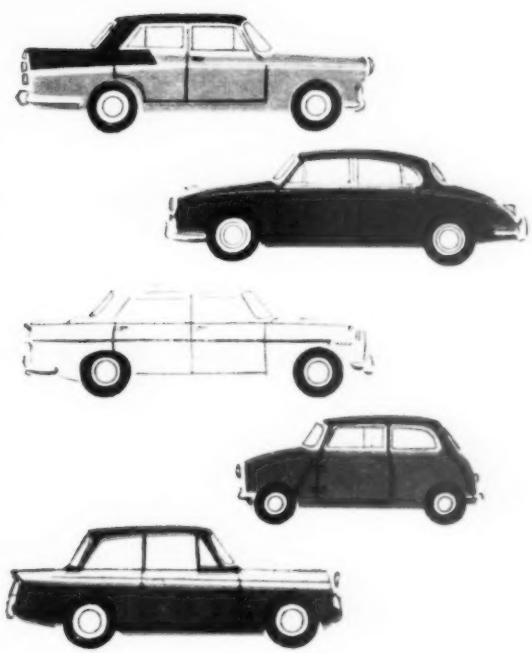

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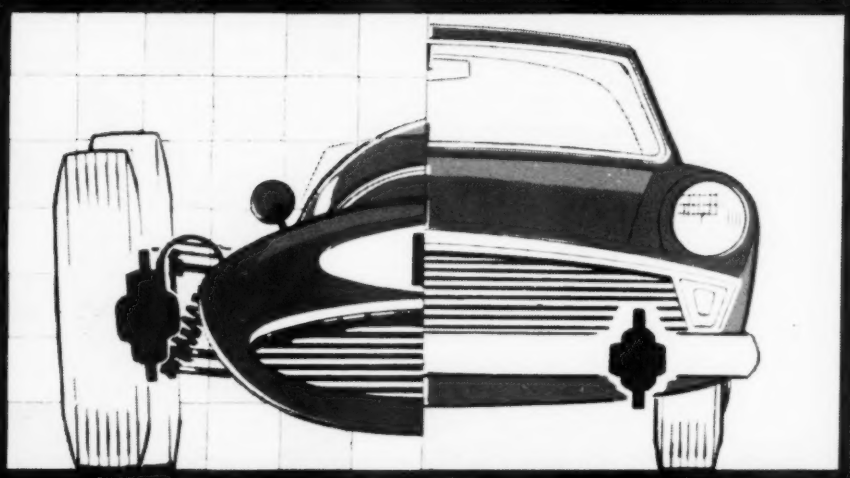

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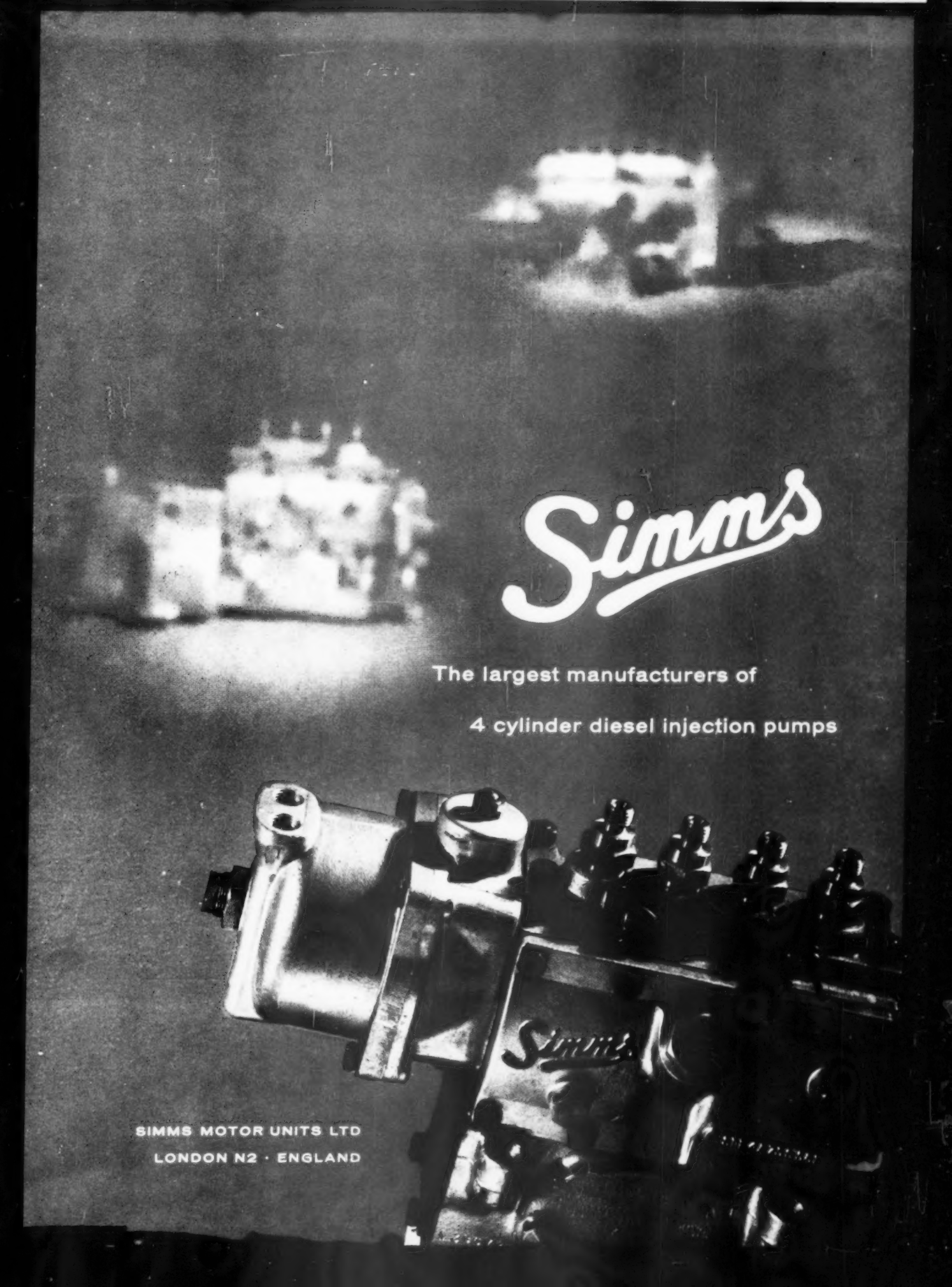
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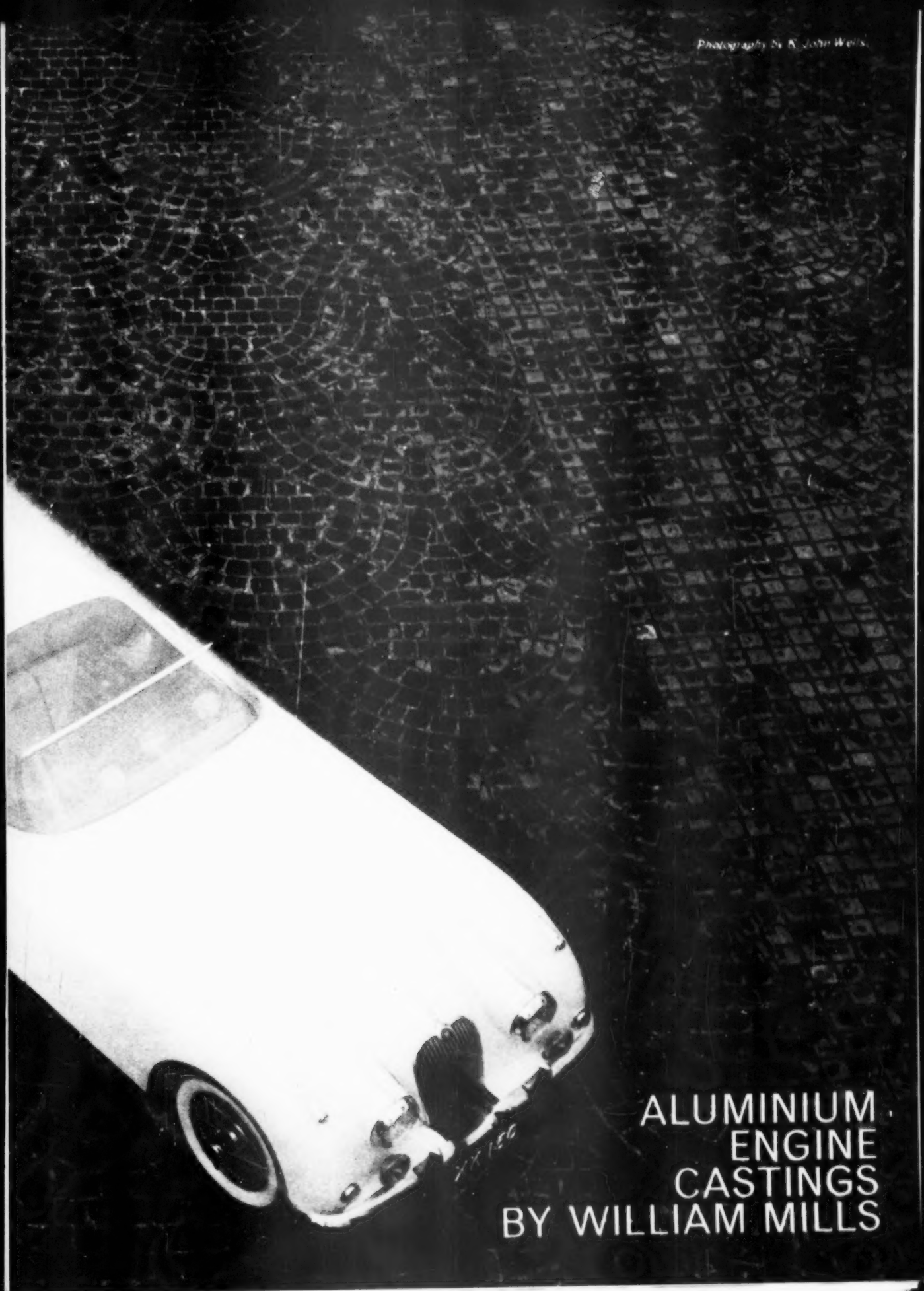
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AUTOMOBILE ENGINEER

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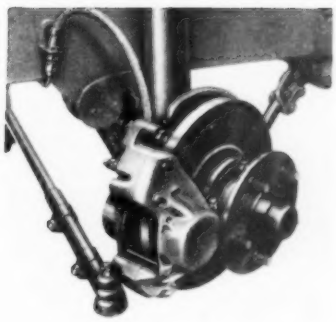

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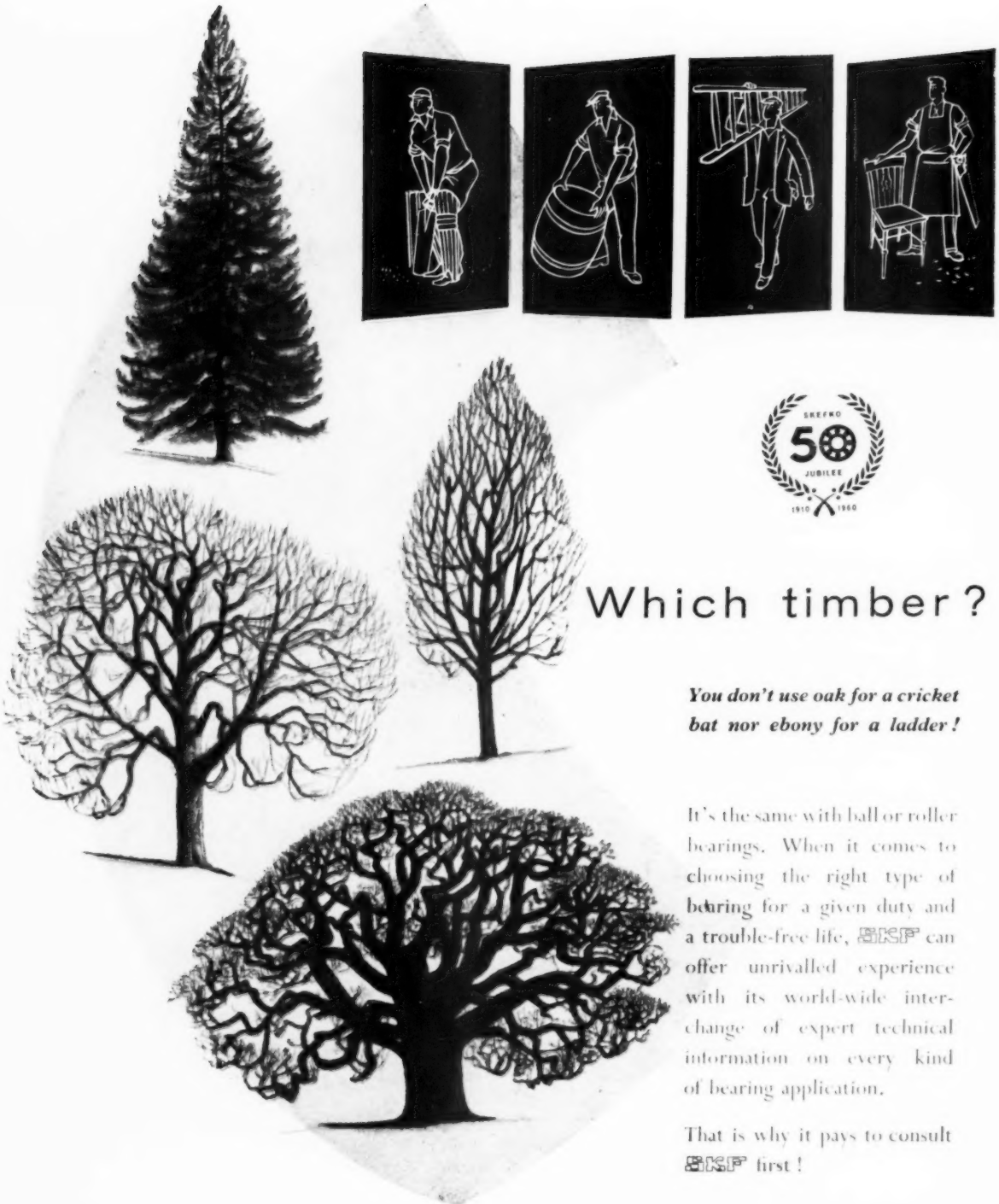

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Reflections on the Show

WITH the almost universal adoption of chassisless construction, and the consequent difficulty of displaying the mechanical components on bare chassis, motor shows in general have tended to lose a lot of their technical interest. This is a serious shortcoming, since a high proportion of potential visitors to the show are in some way or other connected with engineering, and even among those who are not, there are many who are deeply interested in things mechanical. Much could be done to attract these people by displaying not only sectioned engines and transmissions, and steering and suspension layouts, but also by highlighting the good features of these components and how they are achieved. Perhaps it is not sufficiently widely appreciated among engineers that technical showmanship is a valuable adjunct to salesmanship, especially so far as motor vehicles are concerned.

One of the most significant developments in the past year has, of course, been the advent of the compact car in large scale production in the United States. Although the effect of these on exports from Europe has so far been confined mainly to those bound for the American Continent, manufacturers on this side of the Atlantic will soon be faced with competition from these cars in many parts of the world. This should have the effect of hastening technological development. Many problems currently under investigation undoubtedly will now be attacked with a renewed sense of urgency: among them are those concerned with the large scale employment of aluminium in engines, the development of automatic transmissions and of improved rear suspension systems. In addition, a host of details require attention: for example, have British manufacturers paid enough attention to the provision of hot and cold air intakes, for winter and summer operation respectively? Are current lubrication systems good enough, and are we satisfied with filtration, particularly so far as cost of replaceable filter elements is concerned? For how much longer will the traditional hotchkiss drive and rear suspension layout be acceptable, and is the spare wheel outmoded? In the pages that follow, there are comments on all these, as well as on many more aspects of design.

For use in conjunction with modern high-speed engines, the new diaphragm type clutches are a significant advance. They are simple, inherently well balanced, and there is little likelihood of centrifugal force having adverse effects on the spring performance. By introducing an automatic transmission incorporating a hydrodynamic drive, for two cars of popular size, one British manufacturer has demonstrated faith that this type of transmission is suitable for European vehicles in this category. The alternative, of employing the divided drive principle, in which part of the drive is transmitted by a hydrostatic or hydrodynamic device and part mechanically, merits further consideration.

In the United States, there is a slight trend towards the employment of links for positive location of rear axles. Undoubtedly, this arrangement is being adopted to improve stability and handling characteristics and to enable better springing systems to be used. If, despite the fact that it introduces complexity and adds to the cost and, possibly, maintenance requirements, it becomes widely accepted, the stage will be at least partly set for the reintroduction at some later date of air suspension, since hitherto one of the objections to this type of suspension has been that special measures for the positive location of the rear axle are needed.

As is well known, there are very good reasons for having front brakes that are more powerful than those at the rear; in this connection it is of interest that a number of popular saloon cars are being offered with disc brakes at the front and drum type brakes at the rear. The problems with regard to the distribution of braking effort between the front and rear wheels are, of course, more complex when two completely different types of brake are employed, but with the inherently more powerful, fade resistant brakes at the front, at least there should be less danger of rear-end break-away.

There are so many interesting developments afoot that are likely to come to fruition during the coming twelve months that there is little cause to be pessimistic with regard to the trend of attendance figures at the next show. Nor is it essential for the announcement of new development to be held back for the exhibition, but it is desirable to display these new technical features sufficiently prominently to arouse widespread interest and thus attract more people to the show in general and on to individual stands.

London Show Review

ENGINES

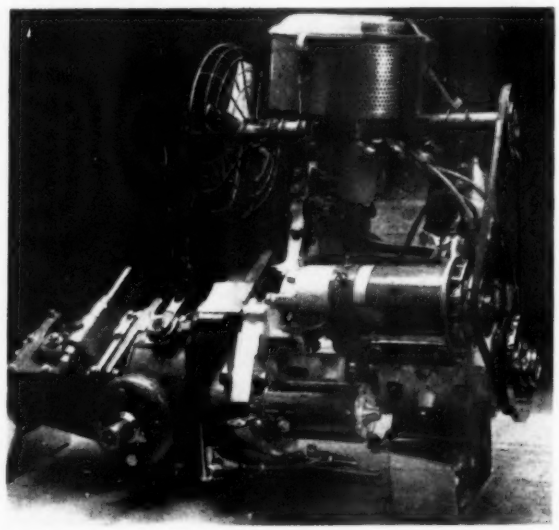
American and European Manufacturers in Direct Competition in Certain Fields; Extended Use of Light Alloys; and Increasing Interest in Centrifugal Oil Filters

A STUDY of the engines at the 1960 Earls Court exhibition revealed the interesting fact that, in general, each power unit type is confined to a limited range of swept volumes. There are the four-cylinder engines covering the range from 750 to 1,750 cm³, the six-cylinder units for the 2 to 3½ litre range, and the V-eight types ranging from 2½ to 6½ litres. In the under-750 cm³ category, many of the engines have two cylinders; some are still of the two-stroke type, but the tendency seems to be towards the adoption of the four-stroke principle. Naturally, there are exceptions to this generalization, but for the purpose of this review, these general groups will be assessed.

Further investigation reveals the development of a highly competitive situation in respect of the American medium size cars and our own, since the engine sizes and outputs of the U.S.A. products are directly comparable with those of many British cars. The competition will be felt not only in America, but also in world markets generally. Contrary to widely held opinion, the U.S.A. has always had a virile export trade, and their engines and cars will now be competing directly with our own in many markets. In order to keep our lead in this class, it will therefore pay us to be heedful of the current trends in American as well as Continental engine design.

On many British engines, a choice of compression ratios is offered to suit different markets; we also have engines with multiple carburettors or multi-choke instruments; we have available aluminium cylinder heads and high-speed engines giving extremely good specific power outputs. Yet, are we doing enough, or are all these developments confined to too few engines? Have we considered closely enough the automatic choke and the warm and cold air intake? Is our engine lubrication adequate, and filtration efficient enough over long periods, to give good engine life? The answers to these questions, and many others, are to be found not only on the stands of the major motor manufacturers, but also on those occupied by no less than 296 accessory and component suppliers—in fact, the motor trade. Britain is fortunate indeed to have such a collection of experts to call on. Enzo Ferrari, head of the renowned Italian company, paid a great compliment to our component manufacturers last year when he publicly thanked the suppliers of bearings, tyres, brakes and many other items for their assistance, which made his motor racing programme possible.

The extended use of light alloys would appear to be one of the main talking points of the 1960 show. For its passenger cars, Rolls-Royce Ltd. is now producing only the V-eight engine, with aluminium cylinder block and head. The American Chevrolet Corvair car embodies over 100 lb of aluminium in its construction, and on the Volkswagen a magnesium alloy is used for the crankcase and the combined gearbox and final-drive housing, and the cylinder heads are aluminium. A.C. Cars Ltd. continue to manufacture their long established six-cylinder engine having an aluminium cylinder block, and Coventry Climax Engines Ltd. offer a whole range of power units, both diesel and petrol, in which both the cylinder blocks and the heads are aluminium; this range includes the amazingly successful 2½ litre racing engine.



Although the Saab 841 cm³ three-cylinder two-stroke engine has been in production for some time, it was a newcomer in this year's London Show

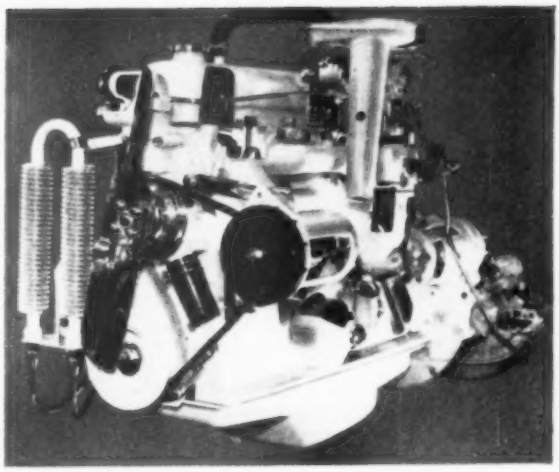
Aluminium cylinder heads are, of course, used by many manufacturers, for sports versions of their standard production engines, which have cast iron heads. From the curves illustrated on the opposite page, it can be seen that, in general, there is a difference of approximately one compression ratio between comparable engines with cast iron and aluminium heads. The curves also show how the ratio, again on comparable engines, has to be reduced as the size of cylinder is increased. The American engines have the highest ratios and the air-cooled units the lowest.

If the situation is analysed in respect of valve-in-head engines, it is clear that two-thirds of the exhibited power units had aluminium heads, the remainder having iron

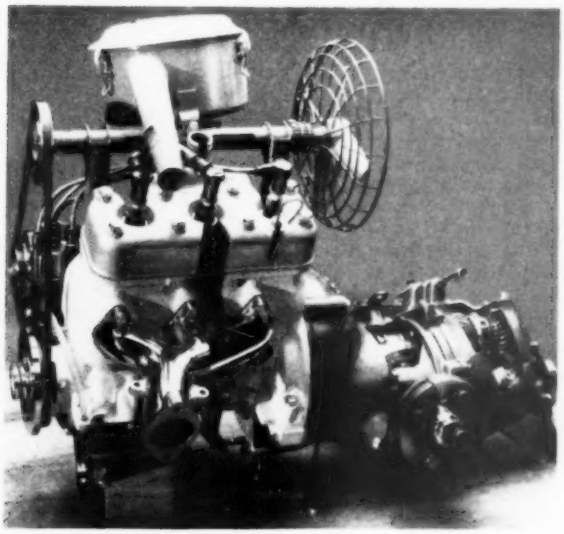
heads. However, the iron heads are probably in the numerical majority, since they include such manufacturers as the British Motor Corporation, the Ford Motor Co, Vauxhall Motors and the Standard Motor Co, none of whom produces an aluminium head. The Rootes Group now has two engines with aluminium heads, both in the Sunbeam range: they are the 1,494 cm³ unit in the Rapier saloon and the generally similar 1,592 cm³ Alpine engine; both have compression ratios of just over 9 : 1. The success of these two models is indisputable and, although no one would presume to say that this is only on account of the engine, it cannot be denied that the recent competition *début* of the Rapier team must encourage sales.

From the graph it can be seen that no manufacturer yet offers, even as an optional extra, a compression ratio high enough to necessitate the use of 100 octane fuel, yet most American engines, having individual cylinder capacities as high as 800 cm³, are operating with ratios of 10 to 10·5 : 1. It would therefore seem that, on our own engines with their smaller cylinders, compression ratios are likely to climb to the 11 or 12 : 1 level, with resulting gains not only in power output, but also in part-throttle economy. A further stimulant to the use of high compression ratios in the U.S.A. has been the introduction of tetramethyl lead. Since this is a more volatile anti-knock agent than the previously used tetraethyl lead, it improves the lead distribution throughout the cylinders, thus rendering fractionally higher compression ratios possible. A super grade fuel embodying this additive is now available in Britain, and it should help to promote a general rise in compression ratios.

Turning now to the question of air and oil filtration, it is apparent that the use of a paper element for both these functions has made great advances within the last year. Paper element air cleaners have been accepted by the engine manufacturers only after exhaustive tests, yet there is a great reluctance to recommend a service life for the elements, as it would appear that the operating conditions can affect this very considerably. For instance, the oily atmosphere present in a diesel engine test shop has been known to reduce the element life appreciably. It would seem sensible, therefore, to ensure that the air intake does not inhale any stray fumes from the crankcase.



The oil cooler on this Vauxhall 2·6 litre engine serves the automatic transmission. An unusual feature is the use of a plastics dynamo-pulley

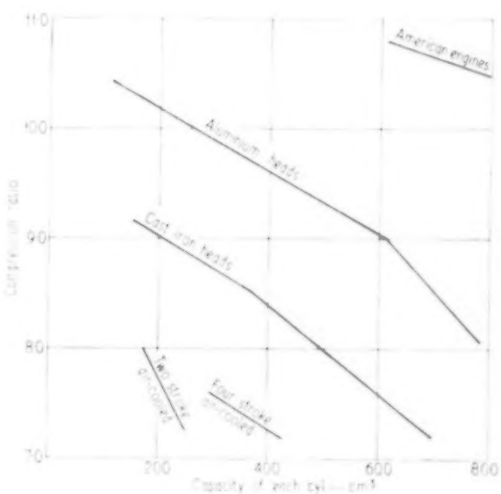


Compactness of the three-cylinder two-stroke arrangement makes it attractive for front wheel drive installations such as on the Saab vehicle

On the Rolls-Royce V-eight engine, the paper element air filter is coupled to the carburettor air intake by a length of flexible hose, and release of one thumb nut allows the unit to be swung aside for access to other components, without disturbing the hose joints. It is to be hoped that as the demand for paper elements increases, thereby making mass production methods feasible, the cost of replacement elements will be reduced very considerably from its present level. Typical recommendations to replace the element at 6,000 miles, having cleaned it at 3,000, are hardly acceptable when the replacement cost is fifteen shillings a time. For very arduous conditions, the oil bath type of cleaner would still appear to be the most favoured.

The installation of oil filters has also been undergoing a

The curves that are reproduced below show how compression ratios tend to vary with type, country of origin and size of engine



change during the past year or so. It would appear that the most favoured layout for quantity produced cars is that pioneered by Ford and subsequently adopted by Vauxhall and Standard : the canister containing the element is bolted directly to a seating on the side of the cylinder block. This method eliminates the filter head, the necessity of securing it to the block, and the sealing of the joint faces against oil pressure; leakage from the canister joint is the reason for the rejection of many engines on test, and it is also a not infrequent cause of annoyance later in the engine's life. The generally recommended procedure is to renew the element every 5,000 to 8,000 miles, and here again the recommendations should be based on a realistic price for replacement elements.

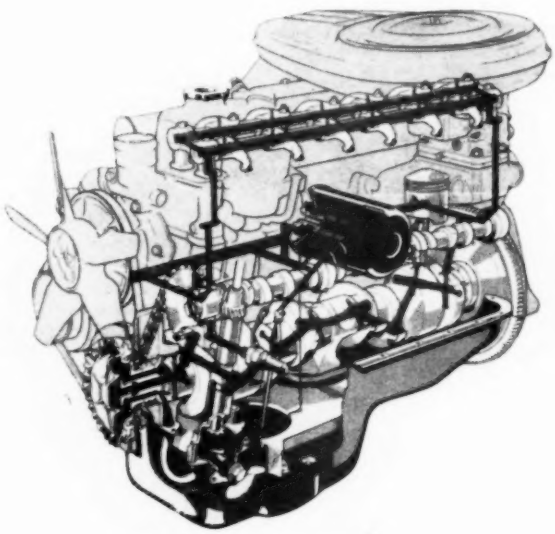
A noteworthy detail of the Humber Super Snipe engine is the fitting of a small oil-wetted gauze element at the upper end of the engine breather downpipe. This is a sensible idea, especially in cases where the engine breathing is connected to the induction system in any way. Filtration is, of course, applied to the crankcase breathing arrangements of a number of commercial vehicle diesel engines.

A new method of oil filtration, introduced in volume production by the Fiat Co. and likely to find popularity in Great Britain, is the mounting of a full-flow centrifugal filter unit on the nose of the crankshaft. Vandervell Products Ltd. have acquired the British rights to this invention and made a feature of it on their stand at Earls Court. Oil is fed from the pump to the centrifugal unit, where any foreign matter is centrifuged to the outside and retained by suitably shaped vanes; the clean oil then enters the crankshaft and is led by drilled passages to the bearings.

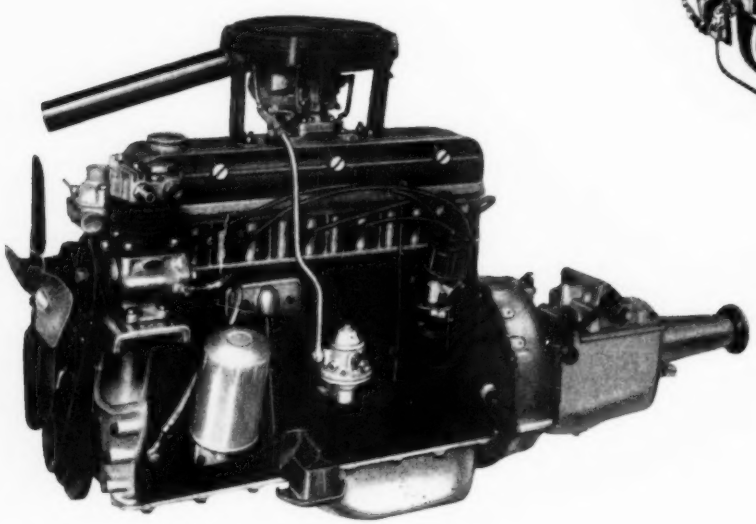
Various schemes for feeding the oil to the filter have been used and several methods of conveying the oil to the bearings suggest themselves. One claim put forward by Vandervell Products is that, by feeding the oil through drilled passages along the crankshaft, the need for cylinder block oil galleries is eliminated, and the block casting thereby simplified. As a result of this feeding arrangement, the customary oil grooves in main bearing assemblies can be eliminated, and it may be possible to reduce the bearing width correspondingly. Any such reduction in the length of an engine would be of great benefit to the designer, especially when laying out a V-eight unit or a four-cylinder engine with five main bearings, since the spacing of the cylinders on these two types is very dependent on the scantlings considered necessary for the crankshaft.

Whether the centrifugal filter alone is sufficient to protect the engine bearings in all conditions of service is debatable. It could, however, be used in series with a normal oil filter, the life of which should be prolonged considerably by the pre-filtering effected by the centrifuge. In assessing the merits of this filter, one is forcibly reminded that the slightly more expensive method of crankshaft drilling used by some manufacturers, which provides centrifugal dirt traps in the crankpins, must be just as effective as the unit mounted on the nose of the crankshaft. Admittedly this internal form

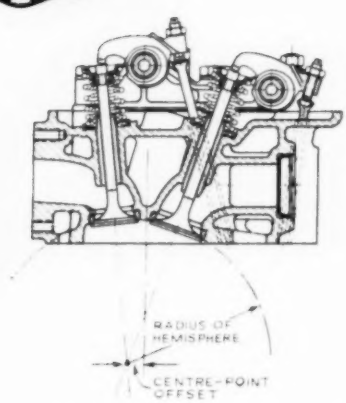
Right: This diagrammatic illustration of the Fiat 1800 engine shows details of the lubrication system. From the sump, the oil is pumped to the centrifugal filter mounted on the front end of the crankshaft; thence it passes through drilled ducts along the length of the crankshaft, feeding the main journals and big-end bearings on its way. From the far end, the oil passes out to a gallery serving the camshaft bearings. A branch from this gallery goes to the supplementary by-pass filter. A restricted feed goes to both ends of the rocker shafts, ensuring uniform distribution



Below: On the Borgward 2½ litre six-cylinder engine, the canister that contains the oil filter element is simply screwed on to its base



Below, right: Layout of the valve gear of the Peugeot 404. The exhaust valve is almost vertical, to give a suitable push rod arrangement. The cast-in inlet manifold has very short port-branches, the ends of which are sealed with core plugs, as shown in section on the right-hand side



of filtration applies to the big-end bearings only, but normally an internally grooved main bearing is not as sensitive to dirt as the big end, which is the final repository for any foreign matter.

On the 105E engine, the Ford Motor Co. uses a combined oil pump and filter head. The arrangement consists of a short horizontal shaft on the offside of the engine, driven by a spiral gear on the camshaft; the outer end of this shaft drives a Hobourn-Eaton rotor type pump. Projecting downwards from the pump casing, which embodies a pressure relief valve, is a canister containing the oil filter. This system makes the oil pump, relief valve and filter unit readily detachable for service operations, and places no restriction on the shape of sump that might be necessary for special applications. The spiral gear on the camshaft is also used to drive the distributor.

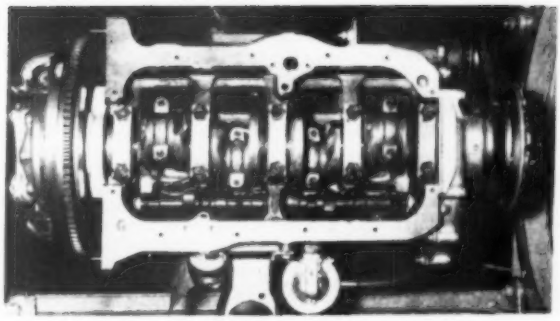
Pistons continue to vary considerably in detail, within their basic limitations of shape. The deservedly popular Ford 105E engine is fitted with Mahle pistons, of German origin but handled in this country by the Birmingham Aluminium Casting (1903) Co. Ltd, who say the split skirt construction and cast-in inserts give slap-free operation over any range of engine temperature normally encountered, always providing, of course, that clearance between piston and cylinder has been carefully selected on assembly.

The grading of cylinder bores to fractions of a thousandth of an inch, in conjunction with the appropriate selection of piston sizes, has now become common practice on even the cheapest of passenger car engines. In addition, the grading of pistons by weight is practised, mainly to overcome the problems introduced as a result of the gradual increase of piston weight, due to die wear, over a long production run. Many manufacturers, notable among them being Ford and Vauxhall, now use the offset gudgeon pin as a means of reducing piston noise.

Piston ring radial depths have tended to increase during recent months: whereas a ratio of bore diameter : radial depth of 26 : 1 was once considered normal, the ratio of several recently designed ring assemblies is about 20 : 1. This change has come about largely as a result of efforts to control the oil consumption at high speeds, a problem that has been underlined by the introduction of motorways. Increasing use is also being made of high radial pressure type oil control rings; the high unit loading is obtained sometimes by narrow contact faces on the cylinder wall, and in other instances by spring expander rings fitted behind the oil control ring.

To extend the life of piston ring assemblies, Specialloid Ltd. now produces pistons having anodized ring grooves, and several other piston manufacturers offer components having cast-in austenitic iron inserts to carry the rings. However, no car manufacturer apparently feels this last type of piston to be worth while specifying as original equipment. There is no doubt that the advent of the chromium plated top compression ring and the use of oils of low viscosity index and mild detergency have considerably prolonged cylinder bore and piston life. We must look, though, to the diesel engine manufacturers for examples of what can be done in the way of engine durability. For the Four 99 engine, for taxi use and passenger car conversion, F. Perkins Ltd. has claimed a top overhaul life of 100,000 miles and a major overhaul life that should exceed 150,000 miles. Nevertheless, the diesel engined passenger cars offered a year or two ago by four or five manufacturers were not to be seen at the Show. Although such vehicles are still available on the Continent, they presumably are not worth offering in Britain, where a log still has to be kept, for inspection by H.M. Customs and Excise, of all fuel bought and mileage run.

A feature of the engines investigated at Earls Court was



On the Simca 1,300 cm³ Rush engine, there are five main journal bearings, and this is another power unit with a centrifugal oil filter at the front

the reversion to the use of a transverse, instead of oblique, division of the connecting rod big-end eyes. Rods with the oblique split suffered from deflections of the longer leg of the eye, which sometimes resulted in bearing failure and cap bolt fatigue. Even on the V-eight engines, in which the obliquely split rod is frequently easier to house, this change of thought was apparent.

New engines

Under this heading, the first British engine that comes to mind is the Standard Vanguard six-cylinder unit. This 2 litre engine has obviously been designed as a direct replacement of the veteran four-cylinder model, and a study of it reveals some interesting facts. The overall length has been kept to the minimum by the use of siamesed bores for all six cylinders of the cast iron block. Water communication from one side to the other of the cylinder block is effected only at the front or rear, or by way of the cylinder head passages. From the pump—mounted on the front of the cylinder head—the water is fed through a distribution tube inserted in the head, and is directed to the hot regions around the valve seats. The water outlet is from the front of the head, through a bellows type thermostat carried in an extension of the pump housing, and into a small cast header tank, which also is bolted to the pump housing.

A further reduction in length has been made possible by the use of a single row chain for the camshaft drive, in place of the duplex chain more commonly used for this size of engine. The simple plate type wheels are housed in a pressed steel cover, and chain tension is maintained by a small, rubber faced spring blade tensioner on the slack run. The belt pulley on the crankshaft nose forms the hub of the torsional vibration damper, which is of the bonded rubber type.

Combustion chambers of the conventional bath tub form are embodied in the iron cylinder head; the valves have vertical in-line stems, and each has its own port. Alternative compression ratios of 7·5 and 8·0 : 1 are offered. The exhaust ports feed into a one-piece cast iron manifold, on which are two pads that form hot spots for the dual Solex carburettors mounted on an aluminium inlet manifold. A three-bolt exhaust pipe joint replaces the four-bolt joint of the four-cylinder Vanguard engine. To give good accessibility for spanners, the manifolds are attached to the cylinder head by clamps as well as bolts.

The four-bearing crankshaft has 2 in diameter journals and 1⅞ in diameter crankpins which, since the stroke is 76 mm, provide a good overlap. How effective have been the efforts to keep the engine compact is well demonstrated by the considerable weight saving relative to the four-cylinder unit: this last weighs 452 lb, whereas the new engine weighs only 395 lb. The maximum torque is 107·5 lb-ft at 2,500 r.p.m, equivalent to a b.m.e.p. of

132 lb/in², and maximum gross and net powers are respectively 85 and 80 b.h.p. at 4,500 r.p.m. Since the bore is 74·7 mm, the swept volume is 1,998 cm³.

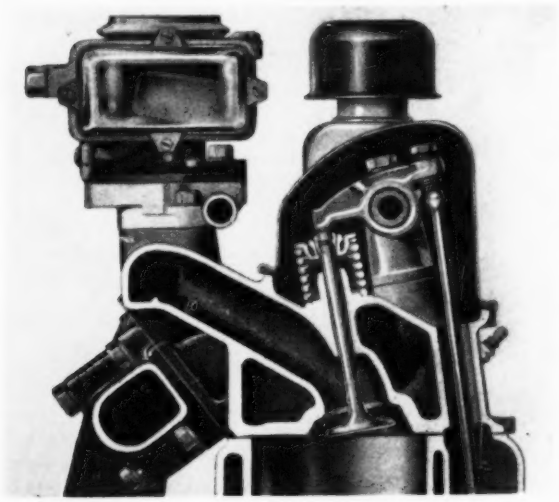
Vauxhall Motors recently announced an increase of the swept volume of their six-cylinder engine from 2·26 litres to 2·65 litres. Although this latest engine closely resembles the previous unit, it is in fact completely new, with a larger bore and stroke—82·55 mm square, as against 79·4 × 76·2 mm. The maximum net power output is 95 b.h.p. at 4,800 r.p.m, but the claimed gross b.h.p. is 113—an unusually big difference. Whereas the maximum torque of the smaller engine was 124 lb-ft at 1,800 r.p.m, that of the new unit is 148 lb-ft at 2,400 r.p.m.

The interesting iron cylinder head has an internal water distribution manifold and wedge type combustion chambers; the compression ratio is 8·1 : 1. Valve guides are dispensed with, the valves operating directly in the head. Two-piece valves are used, a wear resistant stem being welded to a heat resistant head. Mention must also be made of the exhaust manifold thermostat that directs the exhaust gases to the region of the hot spot, to promote rapid warm-up. Matching of the manifold ports to those in the head—an aspect of design that is frequently neglected—is ensured by thin sleeves inserted half into the head and half into the manifold. The big-end eyes of the connecting rods are divided transversely.

Peugeot's new saloon, the type 404, is fitted with a 1·6 litre, four-cylinder engine. This engine is canted towards the right-hand side of the car, at an angle of 45 deg, and has a light alloy cylinder head. The inclined valves in part-spherical combustion chambers are operated by push rods and rockers and a single camshaft carried in the cylinder block. Wet liners are employed : they are sealed at the base by a trapped square-section rubber ring. A feature that to-day is unusual is that the balance weights are bolted to the simple three-bearing crankshaft. The swept volume is 1,618 cm³, derived from a bore of 84 mm and a stroke of 73 mm, and the compression ratio is 7·2 : 1; a single Solex carburettor is employed. An output of 72 b.h.p. is claimed at 5,400 r.p.m, and the maximum torque of 94 lb-ft, developed at 2,250 r.p.m, corresponds to a b.m.e.p. of 144 lb/in².

For the first time, Auto Union was showing at Earls Court the DKW Junior 741 cm³ three-cylinder two-stroke engine, which develops 34 b.h.p. net at 4,300 r.p.m. and has the bore and stroke equal at 68 mm. The compression ratio is 8 : 1. Evidence of the extent to which this simple unit has been developed is the recommended fuel : oil ratio of 40 : 1, or one pint of oil to five gallons of petrol : this is equivalent to about 200 miles per pint, but with no oil changes to worry about. The maximum torque of 47 lb-ft corresponds to a b.m.e.p. of 78 × 2 lb/in². Ignition is effected by means of one coil for each cylinder, the three contact breakers being mounted on the nose of the crankshaft.

The inlet manifold is formed integrally with the cylinder head of the Ford Falcon engine. A fuel weir and good port shape can be clearly seen, as also can the pressed steel retainer for the inlet valve spring



Of similar type is the three-cylinder engine of the Swedish Saab car; although it has been in production for some time, it is a newcomer to the London show. This two-stroke unit, of 841 cm³ swept volume, has a compression ratio of 7·3 : 1 and develops 38 b.h.p. net at 5,000 r.p.m. Since the fuel : oil ratio recommendation is 32 : 1, the oil consumption is slightly heavier than that of the DKW junior. Road tests of both these cars reveal that the fuel consumption is greater than that of their four-stroke rivals—very much so if the engine is driven hard. Nevertheless, the three-cylinder two-stroke engine has an appeal all its own, and the absence of valve gear noise and the smooth torque of the engine provide fascinating motoring.

The American compact cars

With the advent of the medium size American car, several completely new engines have been produced. The following list indicates the units fitted to the so-called compact cars :

Rambler	six-cylinder, side or overhead valve, 3,205 cm³
Chevrolet Corvair	six-cylinder, air cooled, rear mounted, 2,378 cm³
Studebaker Lark	six-cylinder, 2,785 cm³
Plymouth Valiant	six-cylinder, 2,782 cm³
Oldsmobile F-85	V-eight, aluminium block, 3,523 cm³
Pontiac Tempest	four-cylinder, 3,188 cm³
Buick Special	V-eight, aluminium block, 3,523 cm³
Dodge Lancer	six-cylinder, 2,790 cm³ or 3,682 cm³
Ford Comet or Falcon	six-cylinder, 2,365 cm³.

The Chevrolet Corvair represents the biggest breakaway from established practice, since the horizontally-opposed six-cylinder engine is not only air-cooled but also is mounted at the rear. This power unit, which was described and illustrated in the May 1960 issue of *Automobile Engineer*, has a swept volume of 2,378 cm³ (145 in³), the bore and stroke being respectively 3·4375 and 2·6 in. It develops 80 b.h.p. gross at 4,400 r.p.m. and its maximum torque is 125 lb-ft, which corresponds to a b.m.e.p. of 135 lb/in² at 2,400 r.p.m; the compression ratio is 8·0 : 1. This compression ratio is one of the highest that has yet been used for an air cooled car engine. It is of interest that the engine originally had a bore of 3·375 in, giving a swept volume of 2.296 cm³ (140 in³). Owing to the higher horse powers developed by other American compact cars, Chevrolet has introduced an optional version, on which the horse power is increased from 80 to 95 b.h.p. The modifications consist of a redesigned camshaft, stiffer valve springs and a different carburettor. Since carburettor icing has been experienced on this engine, the makers have added a warm air intake that picks up heat from the exhaust manifold area. The main aluminium castings used on this engine are made by a low-pressure process originated in this country for aircraft components and developed since the war by Alumasc Ltd.

Because of the rear mounting, the cooling of this engine is entirely dependent on the belt driven fan, and the unit will very quickly overheat should this fail. A warning light is provided on the dash to indicate any failure of the dynamo to charge, and the fan is driven by the same belt as the generator. To ensure that the light does come on when

necessary, the Chevrolet engineers had to develop a dynamo cut-out that does not pass any appreciable current in the reverse direction. The reason for this is that, originally, belt failures at speeds above the dynamo cut-in speed resulted in the battery motoring the dynamo, and no warning light appeared; consequently, serious engine overheating could be experienced. A second warning light is incorporated that indicates low oil pressure and is illuminated also should the oil temperature get too high.

The 3,523 cm^3 V-eight engine of the new Buick Special has an aluminium cylinder block and is stated to have a gross power output of 155 b.h.p. gross at 4,600 r.p.m, at which the b.m.e.p. is 124 lb/in^2. Although the compression ratio, 8·8 : 1, is quite modest, to enable the engine to run on American regular grade fuel, the creditable maximum b.m.e.p. of 154 lb/in^2 is claimed, corresponding to a torque of 220 lb-ft. The cylinder dimensions are appreciably oversquare, the bore being 3·5 in and the stroke 2·8 in.

Normal casting methods are used to produce the aluminium cylinder block, which has extremely thin, replaceable cast iron cylinder liners; pressure lubricated tappets are employed, running directly in the aluminium. In the cylinder heads, which also are of aluminium, the valves are inclined in wedge type combustion chambers. Following normal V-eight practice, the exhaust ports emerge on the outboard side of each block, and the inlets are between the cylinder banks. To clear the exhaust manifolds, the sparking plugs are fitted at a compound angle on the outboard faces of the heads.

According to the makers, the complete engine has a dry weight of only 350 lb. It can, of course, be misleading to compare quoted weights, unless the exact weighing specifications are known, but a comparison of this unit with the new Standard Vanguard six-cylinder model—itself of less than average weight for a British engine of its type—shows a difference of no less than 45 lb in favour of the V-eight unit. This comparison of two modern engines, one of 3½ litres and aluminium construction, and the other of 2 litres and cast iron construction, highlights the weight savings possible. It is to be expected that this impressive engine will be widely examined with considerable care.

In the Oldsmobile F-85, the same basic engine is employed as in the Buick Special, but different cylinder heads, manifolds and pistons are fitted. The compression ratio is substantially the same, at 8·75 : 1, and the maximum torque quoted by the manufacturers, 210 lb-ft, is 10 lb-ft less than that of the Buick unit; the corresponding b.m.e.p. is 147 lb/in^2.

So far as engines are concerned, the Rambler models, produced by the American Motor Corporation, present a surprising contrast. One car has a completely new aluminium six-cylinder engine, and another, of similar appearance, is powered by a six-cylinder side valve engine. The new engine has a diecast cylinder block, and its cylinder dimensions, of $3\frac{1}{8} \times 4\frac{1}{2}$ in, mark a complete reversal of the bore : stroke ratios of the typical American V-eight engine. Its swept volume is 3,205 cm^3; with a compression ratio of 8·7 : 1, it develops a gross horse power of 127 at 4,200 r.p.m. The maximum torque of 180 lb-ft at 1,600 r.p.m. corresponds to a b.m.e.p. of 139 lb/in^2. A twin-choke carburettor is offered as an optional extra and boosts the power to 138 b.h.p. It is claimed that, by the employment of this new engine, the car front end weight has been reduced by 80 lb.

Also shown on the Rambler stand was the side valve engine previously mentioned, which has the same bore and stroke as the aluminium engine but has a maximum output of 90 b.h.p. The compression ratio is 8·0 : 1, and the maximum torque is 150 lb-ft, equivalent to a b.m.e.p. of 116 lb/in^2. An overhead valve version of this engine is available, in which form, the manufacturers claim, it produces 125 b.h.p.

Although the engines fitted to the Plymouth Valiant and the Dodge Lancer vary in detail, they are basically similar six-cylinder overhead valve units of 2·78 litres swept volume. The bore is 3·4 in and the stroke 3·125 in. In the Valiant, this engine develops 101 b.h.p. gross at 4,400 r.p.m, the maximum b.m.e.p. being 137 lb/in^2 at 2,400 r.p.m. with a compression ratio of 8·5 : 1—an optional alternative compression ratio of 6·9 : 1 is offered. The engine is installed at an angle of 30 deg from the vertical, to allow a long six-branch cast iron, ram type inlet manifold to be housed under the bonnet.

A Chrysler-built alternator is mounted in this installation, and it is belt driven from the crankshaft pulley at about twice engine speed. A feature is made by the company of

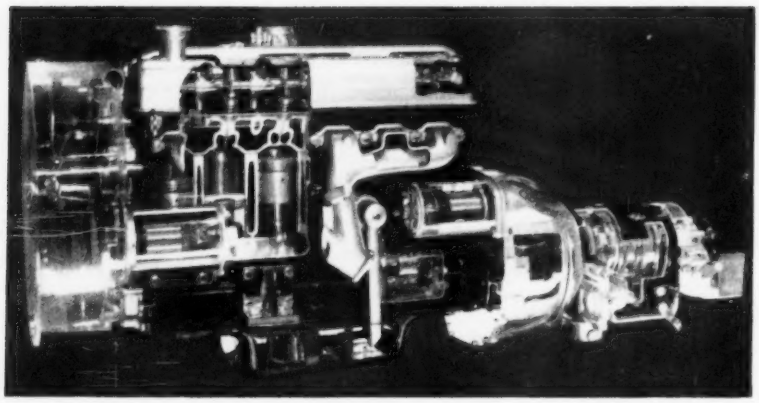
A sectioned 3 Litre engine was among the exhibits on the Rover stand

a smog reducing device fitted to all its cars destined for California: in brief, the crankcase fumes are fed into the inlet manifold and burnt. Presumably, there is a small restrictor in the system, or even a valve similar to the one that used to be manufactured by AC and fitted to Vauxhall cars.

The Studebaker Lark has a completely new engine of 3 in bore and 4 in stroke, giving a swept volume of 2,785 cm^3; it develops 112 b.h.p. gross at 4,500 r.p.m. This unit replaces the original 90 b.h.p, side valve engine of exactly the same swept volume; in comparison with the latter, the new unit shows a torque increase from 145 lb-ft to 154 lb-ft. The compression ratio is 8·5 : 1, and again the recommendation is made to use regular grade fuel.

This is another engine to be fitted with a ram type inlet manifold extending well out from the cylinder head, although in this case the cylinder block is vertical. The design is conventional in most other respects: cast iron is used for the cylinder block and head, and the valves have a small inclination, insufficient to bring the combustion chamber from the earlier bath tub configuration to the wedge form so popular now. To get the very large valves into the length of the engine, they are arranged in a staggered formation; the kidney shape combustion chambers slightly overlap the bores.

Whether the use of these very elaborate ram type manifolds is warranted is questionable. Neither the power output



Left: A noteworthy detail on the Humber Super Snipe engine is the fitting of a small, oil-wetted gauze filter element at the upper end of the engine breather downpipe

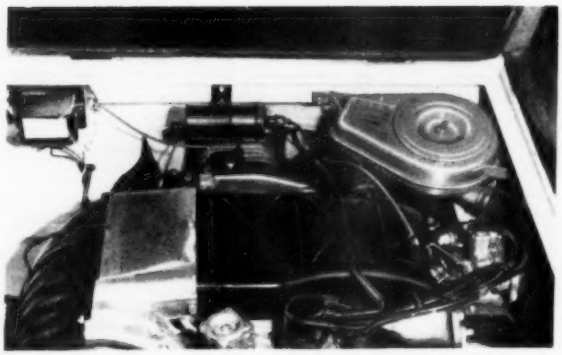
Below: This horizontal version of the Fiat 500D twin-cylinder engine is installed under the floor at the rear of the estate car

quoted nor the maximum b.m.e.p, of 137 lb/in^2, would appear to justify them. It is worthy of mention that, at its junction with the head, the ram passage is 1$\frac{1}{8}$ in diameter.

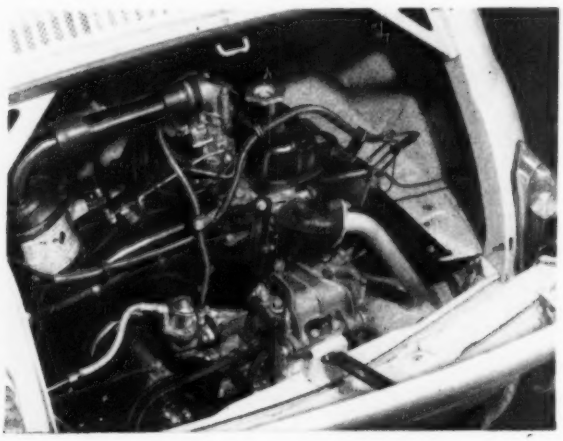
The gear type camshaft drive used in this engine is very unusual nowadays in America, where nearly every other manufacturer employs a chain for this purpose. However, a similar situation is to be found in this country: Rolls-Royce use a gear drive on their V-eight engine, whereas most British engines have a chain drive. For fleet and taxicab use, the Lark engine is available with a smaller-choke carburettor—1$\frac{1}{8}$ in diameter instead of the normal 1$\frac{3}{16}$ in—a practice that is far preferable to the indiscriminate fitting of restrictor plates practised recently by certain car hire companies in Great Britain.

There can be no doubt that, of all the new American engines, the power unit of the new Pontiac Tempest shows the biggest break with convention. It is a big four in the true sense of the term, having a swept volume of 3·2 litres; the bore and stroke are respectively 4$\frac{1}{16}$ in and 3$\frac{1}{4}$ in. In its standard form, with a single-choke carburettor and a compression ratio of 8·6:1, the engine produces 130 b.h.p. An optional, premium fuel version, having a compression ratio of 10·25:1, gives 155 b.h.p.

The engine is basically the right-hand bank of the existing Pontiac V-eight engine, and can probably be machined on the same transfer line. This would seem to be a wasteful way of building an engine, especially one of this size. The cylinder spacing of a V-eight engine is of necessity greater than that of a straight four-cylinder unit, because side-by-side connecting rods have to be accommodated on the crankpins, and this must make the engine considerably heavier than it need be. Whether the design is justified by the economy of machining and assembling the engine as half the V-eight unit, time alone will tell. The Buick aluminium V-eight already described is offered as an alternative, however, and combined with the other interesting features of this car, should make it a very acceptable vehicle.



In the U-shape component of the rear mounting for the vertical version of the Fiat 500 cm^3 engine, a coil spring carries the vertical load, and shouldered rubber bushes in the pivot eyes provide damping. A similar mounting is used when the engine is installed horizontally, as in the station wagon layout which is illustrated above in the right-hand column of this page



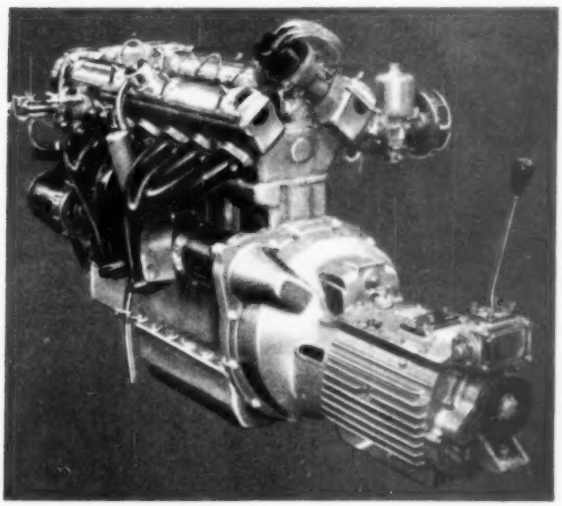
This completes the review of the engines of the American compact cars, apart from that of the Ford, which was not exhibited at Earls Court. The latter is a conventional in-line six-cylinder engine of 2,360 cm^3 swept volume; it is designed on similar lines to the British Ford Zephyr. Briefly, this latest range of American engines can provide horse powers from 80 to 130, and torques from 125 lb-ft to 180 lb-ft; there is a choice of four, six or eight cylinders, and one air cooled unit. Their most competitive features, however, must be the weight saving resulting from the large-scale use of aluminium, and the economies in manufacture that result from pressure diecasting the cylinder block. In this respect, it should be quite feasible to produce aluminium blocks for many of our smaller engines on the diecasting machines already available here.

British engine developments

The British Motor Corporation, series B, 1,489 cm^3 engine now has a modified combustion chamber, to minimize pre-ignition, and a modified cam form that reduces tappet noise. This engine is, of course, offered in 1·6 litre form in the MGA sports car. Its increased swept volume has been obtained by enlarging the bore from 73·025 mm to 75·39 mm, without altering the stroke of 88·9 mm. The output of the twin-carburettor 1$\frac{1}{2}$ litre engine, as fitted in the M.G. Magnette and Riley saloons, is 66·0 b.h.p. gross at

5,000 r.p.m, and that of the twin-carburettor 1,588 cm^3 unit in the MGA car is 83·0 b.h.p. gross at 5,600 r.p.m. A 26 per cent increase of power, for a 7 per cent increase of swept volume, without a change in the compression ratio of 8·3 : 1, obviously suggests further differences, probably in the camshaft and exhaust system. In this connection, it is worthy of note that the MGA has a small pancake type air filter on each carburettor, in place of the larger single filter of the other engine, which probably improves the top end power output. The maximum torque of the 1·6 litre unit is 87 lb-ft at 4,000 r.p.m, whereas that of the two-carburettor 1½ litre version is 82 lb-ft at 2,500 r.p.m.

Another car to be fitted with an engine enlarged from 1½ to 1·6 litres is the Sunbeam Alpine Mark II. This engine has an aluminium cylinder head, a compression ratio of 9·1 : 1, twin Zenith carburettors and a four-branch exhaust manifold, all of which features contribute to a high net



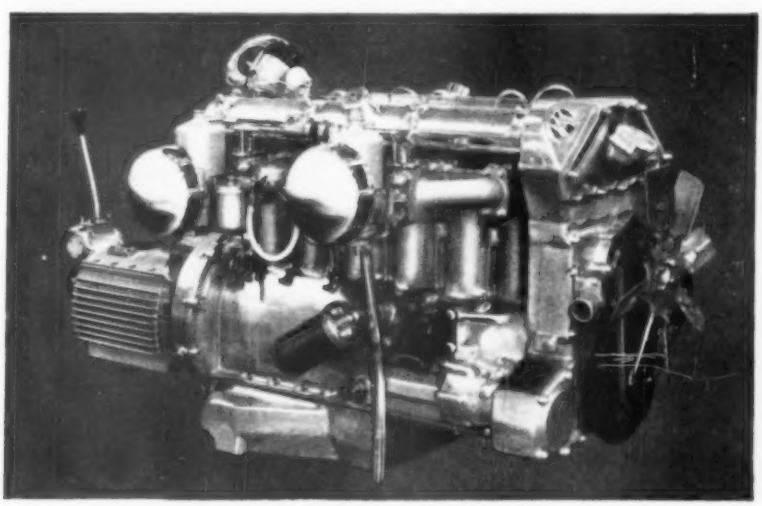
output of 80 b.h.p. at 5,000 r.p.m. The transition from 1,494 cm^3 to 1,592 cm^3 has been accomplished by a 2·5 mm increase in the bore size, to 81·5 mm. Other changes found desirable have been an increase of crankpin diameter, from 1⅞ in to 1⅞ in, and the use of larger oil and water pumps. The maximum torque of 94 lb-ft at 3,800 r.p.m. is a highly creditable figure and corresponds to a b.m.e.p. of 146 lb/in^2; in fact, the b.m.e.p. of this engine is over 140 lb/in^2 from 2,700 r.p.m. to 4,500 r.p.m.

Lotus Engineering Co. Ltd. is now producing a Series II version of the Elite sports coupé fitted with a Coventry Climax 1,216 cm^3, four-cylinder engine. The engine has two S.U. carburettors and is rated at 83 b.h.p. net at 6,500 r.p.m; its maximum torque of 77 lb-ft, corresponding to a b.m.e.p. of 156 lb/in^2, occurs at 4,750 r.p.m. In spite of its high compression ratio of 10 : 1, this powerful unit is known to have covered very high mileages on normal premium grade fuel. By virtue of the use of light alloy for the cylinder block and head, a weight of only 220 lb has been achieved for the engine complete with carburettors, manifolds, electrical equipment and flywheel.

A single overhead camshaft operates the inclined, in-line valves directly through the medium of inverted bucket type tappets, and a wedge shape combustion chamber is used. The main change made during the year has been to the R.R.56 light alloy main bearing caps, which are now forged instead of cast. This change was dictated by instances of fatigue failure of the caps after considerable mileages. The useful lesson to be learnt here is that sand cast light alloy caps should not be used in a high-performance engine, although a pressure diecasting will give a fatigue life comparable with that of a forging of the same basic material. With regard to sporting engines, the Morgan Motor Co. Ltd. exhibited a tuned version of the Triumph TR3 engine fitted to their Plus 4 car. This engine has two Weber dual-choke carburettors and a swept four-branch exhaust system; its output of 116 b.h.p. at 5,000 r.p.m. is 16 per cent higher than that of the standard unit.

A stroke : bore ratio of 0·6 : 1 immediately calls to mind only one engine, the Ford 105E, which has just completed its first year in production. In its standard form, with a compression ratio of 8·9 : 1, this 997 cm^3 engine has a net output of 39 b.h.p. at 5,000 r.p.m, yet in the motor sporting world figures of 80 to 85 b.h.p. are glibly quoted for tuned versions, running up to 8,000 r.p.m. Clearly this engine must be regarded as one of the outstanding units of the year, its success almost eclipsing that of the remarkable Coventry Climax 2½ litre grand prix engine.

The engine that most nearly approaches the 105E in terms of the stroke : bore ratio is the Ford Falcon six-cylinder unit, which has a ratio of 0·715 : 1. Then, in succession, come the Chevrolet Corvair, at 0·77 : 1, the Facel Vega Chrysler unit, at 0·795 : 1, the Buick Special, at 0·798 : 1, and the Ferrari V-twelve engine, at 0·805 : 1. Seventh on the list is the



Above and on the right are two views of the Aston Martin 3·7 litre engine. Aluminium is used extensively in the construction of this unit which, with the S.U. carburettors, has an output of 240 b.h.p. at 5,500 r.p.m.

Daimler Majestic Major 4,561 cm^3 V-eight engine, which has a ratio of 0·841 : 1.

Among the British six-cylinder engines, the development of the Humber Super Snipe 2,965 cm^3 unit has continued, the main effort having been directed towards obtaining greater refinement. For quieter running, the cooling fan now has four blades instead of eight. An unusual feature is the use of steel backed, indium coated lead-bronze bearings for the crankshaft front main bearing and the two intermediate bearings; the rear bearing continues to be of the steel backed micro-babbitt type. The oil pump speed has been raised to increase the flow to the bearings and to assist their cooling. Exhaust valves to the American specification 21-4N are used; it will be recalled that the valves are radially disposed in part-spherical combustion chambers, and are operated by push rods and rockers from a single camshaft in the cylinder block. This engine has a net output of 121 b.h.p. at 4,800 r.p.m, and its maximum torque and b.m.e.p. are respectively 161·5 lb-ft and 135 lb/in^2 at 1,800 r.p.m.

The Ford Zephyr 2,553 cm^3 engine is now very familiar and has established an enviable reputation for smoothness and longevity. In its standard form, with a 7·8 : 1 compression ratio, the power output is 85 b.h.p. net at 4,400 r.p.m. However, a modified version is fitted to the new Lea-Francis Leaf-Lynx. In this guise it has three carburettors and a a revised exhaust manifold, alterations that raise the output to 107 b.h.p. net at 4,500 r.p.m. For increasing the power of this basic engine, Rubery, Owen and Co. Ltd. market an aluminium cylinder head of the opposed port type, an example of which was to be seen on their stand at the motor show.

Jaguar Cars Ltd. have not had to make any significant changes to their three highly successful six-cylinder engines, of 2·4, 3·4 and 3·8 litres swept volume. All three engines, of course, have a common design of cylinder head, which carries the twin overhead camshafts and incorporates combustion chambers of segmental spherical form. The 3·8 litre series S engine is an outstanding example of the high-performance type. It has three carburettors, straight inlet ports—in place of the offset, swirl ports of the other engines —and a compression ratio of 9 : 1. The power output is 265 b.h.p. at 5,500 r.p.m, equivalent to just over 70 b.h.p/litre, and the maximum b.m.e.p. of 172 lb/in^2 at 4,000 r.p.m. results in the very high torque of 260 lb-ft.

This b.m.e.p. figure of 172 lb/in^2 was equalled or surpassed by only four other engines exhibited at the show: they are the Aston Martin DB4 G.T, the Coventry Climax 2 litre engine and the Mercedes-Benz 300 SL and 220 SE. By virtue of their high compression ratios, some of the large American V-eight engines run very close to this figure, however: Buick quotes a maximum b.m.e.p. of 167 lb/in^2, and Cadillac 166 lb/in^2. The output of the Mercedes-Benz 220 SE must be considered extremely good for a 2·2 litre, single overhead camshaft design, with a compression ratio of 8·7 : 1, but it should be remembered that this engine has petrol injection equipment. Its sister engine, the 220 S, which features compound Solex carburettors, has a maximum b.m.e.p. of only 158·2 lb/in^2, and with the same compression ratio.

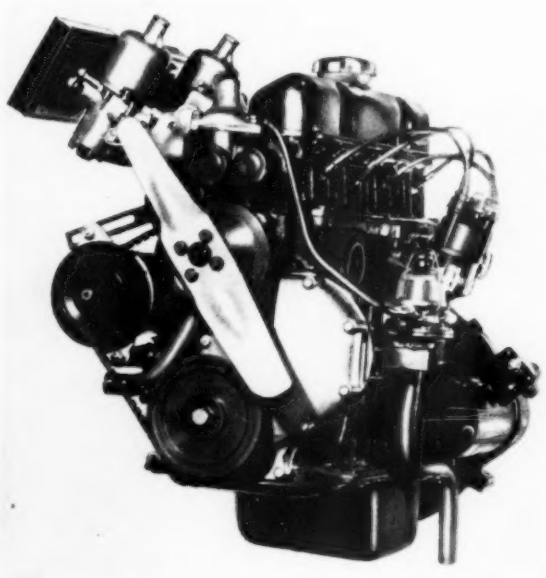
The A.C. 2 litre long-stroke engine was originally designed in the nineteen-twenties but, by constant development, it still remains abreast of current trends. It has wet liners in an aluminium cylinder block, and a cast iron cylinder head carrying a single overhead camshaft; an unusual feature is that the chain drive to the camshaft is at the rear of the engine. In theory, of course, this is a very good location for the camshaft drive, since it avoids cyclic speed variations of the shaft caused by the torsional flexibility of the crankshaft. The only change since last year is to the 1,991 cm^3 version fitted to the Aceca model: this now has three S.U. carburettors in place of the Solex instruments previously employed.

No modifications of a major nature have been made to the three British V-eight engines—the Rolls-Royce 6,230 cm^3 and the Daimler 2,549 and 4,561 cm^3 units. All three were described in *Automobile Engineer* last year, both in the New British Cars features and in the London Show Review. The dry weight of the Rolls-Royce engine, which has an aluminium block and cylinder heads, is 561 lb: this figure is for the unit complete with starter, dynamo and exhaust manifolds. Development has been confined to enhancing the degree of refinement of the performance. A lot of attention has been paid to improving the action of the automatic choke. In the interest of quiet operation, the fan has five unequally spaced blades and is run at just below engine speed.

The Daimler 4,561 cm^3 V-eight engine, which was not announced until the Motor Show last year, is now in production. Its layout follows that of the smaller unit of the SP.250 sports car, in having part-spherical combustion chambers in the aluminium cylinder heads; the included angle between the inlet and exhaust valve stems is 70 deg. A single camshaft, mounted between the banks of cylinders, actuates the valves by means of push rods and rockers. Of interest is the use of non-rotating, curved face tappets, running directly in an aluminium carrier casting. The compression ratio is 8 : 1.

This larger Daimler engine develops 220 b.h.p. gross at 5,500 r.p.m, and its dry weight of 515 lb includes all the electrical equipment and the carburettors, though it excludes the flywheel. To achieve this creditably low weight, the stroke has been kept short—it is 80·01 mm—and the very simple, iron cylinder block casting is not extended below the horizontal plane through the crankshaft axis. Aluminium is used not only for the cylinder heads but also for the sump, rocker gear covers, inlet manifolds as well as the tappet carrier already mentioned. An interesting comparison of powers and weights can be made between the 4·56 litre Daimler V-eight and the standard Jaguar 3·8 litre engine, which has the same output at the same r.p.m. Since the

The new Volvo P1800 coupé, which is to be assembled in Great Britain, is powered by this engine with two steeply inclined S.U. carburettors



Jaguar unit weighs 580 lb, the Daimler one shows an advantage of 65 lb; in addition, it has a higher torque, 283 lb-ft at 3,200 r.p.m. as against 240 lb-ft at 3,000 r.p.m.

Continental engines

In this category, no less than thirty-one different makes, including those from behind the Iron Curtain, were displayed at Earls Court. Of these, only Facel Vega, Ferrari, Maserati and Mercedes-Benz offer engines of over 2½ litres swept volume, this being the minimum size considered necessary by the American manufacturers for their compact cars. Like the others in the Abarth range, the new rear mounted 1000 engine is basically a Fiat unit, but considerably altered: one of the principal differences is the use of two overhead camshafts. Little information regarding the detail design was available, but the power output is said to be 90 b.h.p.

Although it had been announced before last year's exhibition, the Facel Vega Facellia was not shown on that occasion, but it did appear this year. The 1,646 cm³ four-cylinder engine of this car is made by Facel S.A. in Paris, whereas the larger cars of the range are, of course, fitted with Chrysler power units. An 82 mm bore and a 78 mm stroke have been adopted, and the crankshaft has five main bearings. The inclined valves in the part-spherical combustion chambers are actuated by twin overhead camshafts and inverted bucket type tappets; a compression ratio of 9·4:1 is employed. Carburation is effected by means of a Solex twin-choke instrument, and a duplex exhaust is used.

That this engine should have a gross power output of 115 b.h.p. at 6,400 r.p.m. indicates efficient breathing. Consequently, it comes as no surprise to learn that Harry Weslake had a hand in the development. Unfortunately, no torque figures were quoted by the manufacturers, but a brief calculation reveals that the b.m.e.p. at peak power is unusually high at 142 lb/in².

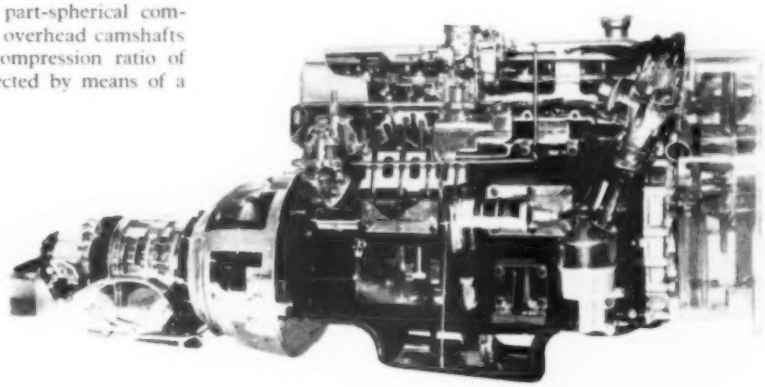
The Fiat 500 parallel twin-cylinder air cooled engine is by now familiar to most followers of automobile engine design. However, a novelty on the Fiat stand this year was the Giardiniera, or station wagon model, in which the unit is installed with its cylinder axes horizontal instead of vertical. The purpose of this considerable modification to the installation is the avoidance of an inconvenient step in the floor of the stowage compartment at the rear of the body. Changes have, of course, had to be made to the induction, exhaust and lubrication systems, and these have all been carried out with typical Fiat thoroughness.

Two interesting details were noted on Fiat engines. One is a moulded, combined heat insulating washer and drip tray that is fitted beneath the downdraught carburettor; it embodies a drain pipe to lead any spillage clear of the exhaust system. The other detail is the use of high-tension leads of unusually small diameter, about ⅛ in, the distributor and plug connections being made to suit. Mention has already been made of the centrifugal oil filter which, on the 1800 and 2100 units, is employed in conjunction with a second filter of the by-pass type.

No changes of any moment have been made to the two current Lancia engine designs—the Appia narrow-V four-cylinder of 1,090 cm³ and the 60 deg V-six, 2,458 cm³ Flaminia. In view of the upsurge of interest in aluminium engines, though, it should perhaps be mentioned that the first-mentioned unit has an aluminium crankcase, to which is bolted a cast iron cylinder block. In the Flaminia engine, the orthodox block and the cylinder heads are all of aluminium.

Unfortunately, the new Lancia Flavia car was not announced early enough for it to appear at Earls Court. Information subsequently acquired, however, indicates that the engine breaks entirely new ground for this famous company. It is a four-cylinder horizontally opposed unit of 1,500 cm³ swept volume, with water cooling. The bore and stroke are respectively 82 and 71 mm, and the cylinders are fed by a twin-choke Weber or Solex carburettor. Again, aluminium is employed for the crankcase-block casting and for the cylinder heads, which have unusually flat part-spherical combustion chambers.

The included angle between the inlet and exhaust valve stems is only 39 deg, and the stems are all in the same horizontal plane. This is made possible by the use of individual, vertical spindles for the rockers, after the fashion of the majority of motor-cycle engines. The two chain driven camshafts are sited below and to each side of the crankshaft, and actuate the rockers through the medium of orthodox push rods. This layout of the valves is not new to Lancia, though it has been previously used on the Aurelia engine.



An unusual feature of the Humber Super Snipe engine is that steel backed, indium coated lead-bronze shell type bearings are employed for the front and intermediate main journals, whereas the rear bearing is still of the steel backed micro-babbitt type

It is worthy of mention that the main and big-end bearings are supplied by Vandervell Products Ltd. and are of the indium infused lead-bronze type. Another British component is the oil pump, which is a Hobourn-Eaton product. To add to the international nature of the engine the pistons are made by the German Mahle company. The net power output of the engine is 78 b.h.p. at 5,200 r.p.m, and its maximum b.m.e.p. and torque are respectively 135 lb/in² and 82 lb-ft at 3,500 r.p.m, a relatively high speed for this type of unit.

Extensive changes have been made to the extraordinarily successful and durable Volkswagen engine. The net power output has been increased from 30 to 34 b.h.p, by redesigning the combustion chambers, increasing the compression ratio from 6·6 to 7·0:1 and the fitting of a modified camshaft. Although the bore and stroke are unchanged, the distance between the cylinder axes on each side has been increased appreciably, to provide a better flow of cooling air between the adjacent walls. This change has necessitated a new crankshaft and crankcase: the crankshaft has thicker webs and larger-diameter journals than before, and the crankcase has also been strengthened, though it remains a magnesium alloy diecasting. Further details of the modifications were given in the normal November issue of *Automobile Engineer*.

An Unusual Semi-Downdraught Carburettor Arrangement: A New Petrol Injection System Under Development

Carburation and Induction Systems

Triple S.U. carburettor layout on the Ford Zephyr engine in the Leaf-Lynx sports car

SHORTLY before the 1959 Show, it became obvious that, in Great Britain, there was a pronounced trend towards larger power units, with an attendant enlargement in breathing areas and carburettor bores. This year the trend has continued, and still more models are equipped with engines of increased swept volume. On the downdraught type of carburettor, which still retains wide popularity, this increase in carburettor bore presents some problems because a larger throttle bore means an increase in height. Owing to the low bonnet profiles now favoured by the stylists, the underbonnet accommodation of the carburettor and its air cleaner has become a critical consideration. However, the carburettor designers have taken steps to meet the altered requirements, and the dwarf downdraught carburettors, which were brought into production some four years ago, when this difficulty first became apparent, have now proved themselves by performing extremely well in every respect.

Virtually all the downdraught carburettors at the Show were of the open-choke pattern, and on the American exhibits this type was universal. Many of these American instruments are four-barrel carburettors, compounded as one primary and one secondary pair. The primary barrels provide the mixture for part-throttle cruising, while the secondaries meter the mixture for high power. There was a considerable increase in the number of American compact cars exhibited, and on these vehicles the carburation systems were orthodox.

The other basic type of carburettor, exhibited mainly on British cars, is the S.U. constant vacuum instrument. In some instances these carburettors are mounted horizontally, while in others they are in the semi-downdraught, or inclined, position. On the S.U. carburettor the provision for cold starting is generally the lowering of the jet needle sleeve, and there is a linkage mechanism that simultaneously opens the throttle slightly. A few cars have the S.U. auxiliary enrichment system, a device that automatically provides the rich mixture for cold starting.

Nearly all the open-choke carburettors, on the other hand, are fitted with semi-automatic strangler valves, with a fast idle linkage. Some of the Continental cars have open-choke instruments with an automatic strangler arrangement; others are equipped with the Solex Thermostarter, an automatically controlled auxiliary carburettor. Most of the open-choke instruments on British cars are produced by the Zenith and Solex companies, and many of the Continental vehicles have Solex carburettors, although Zenith also is well represented; the American cars are equipped with Carter, Stromberg, Rochester or Holley instruments.

Almost every American car exhibited at Earls Court was equipped with an automatic choke, but here a most interesting trend was evident. When the automatic choke was first introduced in America, about 1930, the bimetal thermostat spring assembly was mounted on the exhaust manifold. On subsequent units, the thermostat assembly was housed inside a chamber recessed into the exhaust manifold; this arrangement continued in production for many years. Then, towards the end of the 1930s, Stromberg and Carter brought out carburettors in which the automatic choke was housed in a small chamber on top of the carburettor, and the thermostat spring operated directly on the end of the strangler spindle. By means of channels within the carburettor and an external tube, heated air from a small stove on the exhaust manifold was drawn over the thermostat spring to effect the automatic control.

For a long time, this system has been almost universally employed. This year, however, certain of the latest American models have the thermostat spring assembly once more in the exhaust manifold. Among these cars are the Plymouth Fury and Valiant, the Rambler Six and the Chrysler New Yorker. The carburettors concerned are Stromberg, Carter or Ball and Ball, a firm which is a part of the Carter organization. This change is possibly attributable to the fact that on current engines, the heat accumulator effect of the exhaust manifold mass is greater than on earlier units, and this has the effect of keeping the automatic choke out of action for a longer time after the engine has been stopped.

As in previous years, automatic economy systems, for providing economically lean mixtures for part-throttle cruising, are in widespread use, particularly on open-choke carburettors. In a few instances where the S.U. carburettor is specified, the economy system is of the back-suction type developed by the S.U. Carburetter Co. Ltd.

Although fuel tanks are still almost invariably at the rear of the vehicle, the long-popular arrangement of a low mounted, flat rectangular tank has given way to a variety of other schemes. In some instances, such as certain B.M.C. cars, the tank is mounted transversely behind the rear seat squab. On the Triumph Herald, the tank is at the left-hand side of the luggage compartment, behind the wheel arch; Jaguar, however, favour two separate tanks built into the rear wings, one on each side.

Pumps for the transfer of the fuel from the fuel tank to the carburettor have changed but little. The two types commonly employed are still the AC mechanically operated unit, driven from the engine camshaft, and the S.U. electric pump. All the American cars exhibited had the mechanical type of pump, in some instances of the Carter design that incorporates a suction pump for the windscreen wiper. Most Continental exhibits, too, had mechanical pumps, as also have

numerous British cars, but all the B.M.C. models are equipped with electric fuel pumps.

On several cars, positive measures have been taken against carburettor icing. For example, on the Peugeot 404 and the Ford Falcon, the throttle body of the carburettor is jacketed for coolant circulation. This arrangement has been used in the U.S.A, but it has the disadvantage that the cooling system is disturbed if the carburettor has to be removed for servicing. On the other hand, the export version of the Morris Minor 1000, fitted with the standard single semi-downdraught S.U. carburettor, features an expedient that is also employed on some other B.M.C. models: bolted between the carburettor and the induction manifold is a gasket of heat resistant material about $\frac{1}{8}$ in thick. This gasket carries a small domed thermostat switch and an electrical heating coil element, the function of which is to heat the surroundings and the mixture sufficiently to prohibit ice accretion; in addition, a second heater element is clamped round the outside of the suction piston chamber. The thermostat switch is so connected that, when the ignition is on, the heater elements are in circuit. When the engine has attained a certain temperature, the thermostat switch breaks the circuit and the heater elements are automatically put out of action.

So far as the other end of the temperature scale is concerned, the Mercedes-Benz 220S has an interesting device that combats vapour pressure problems in hot weather. This car is equipped with two Solex twin-barrel downdraught carburettors. On the float chamber cover of the front carburettor, just above the petrol inlet, is a small relief valve with a protruding stem. Bearing against this stem is a light steel strip spring, the lower end of which is connected to the acceleration pump mechanism. There is also an extra petrol pipe running back from the relief valve body to the fuel tank.

This device operates as follows. When the throttle opening is large, and a high rate of fuel delivery is required, the spring moves away from the valve stem, permitting the relief valve to close, so the fuel delivered to the carburettors is under maximum pressure. On the other hand, when the throttles are at the idle position or their opening is small, the spring presses against the valve stem and allows a certain amount of fuel to be by-passed back to the tank. This action relieves the fuel pressure on the carburettor float needle valves, by preventing the build-up of excessive fuel pressure owing to vapour formation in the fuel line.

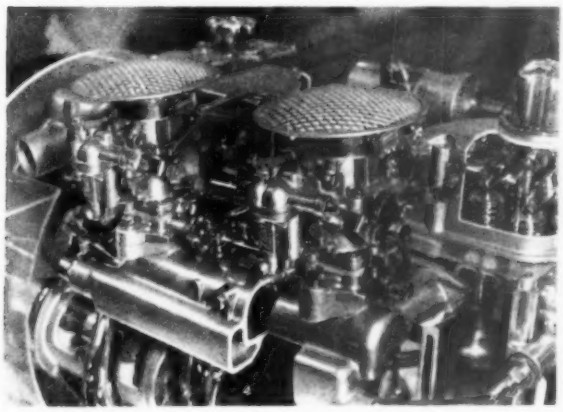
The four-cylinder engine of the new Peugeot model 404 has a swept volume of 1,618 cm^3 and a bore and stroke of 84 mm and 73 mm respectively; this stroke is common to both the 404 and the smaller 403 units. As in the case of the Plymouth Valiant, the engine is installed with its cylinder block inclined to one side: the plane through the cylinder axes makes an angle of 45 deg with the vertical. This layout is basically an excellent one, and indeed the writer has advocated it for many years. It provides more room for the carburation system than does a vertical installation, and thus enables the bonnet profile to be lowered, if desired. In addition, it results in a lower centre of gravity of the front end assembly, and makes more space available for such other accessories as the starter motor, dynamo and oil filter. On the 404 unit, the combustion chambers are of segmental spherical form, designed to promote a high degree of turbulence, and the included angle between the inlet and exhaust valve stems is less than on the 403 model that has been in production for some years.

A single Solex 32-PBICA downdraught carburettor supplies mixture to the riser, which is bolted to the left-hand side of the cylinder head. This riser is unheated and is curved laterally to feed the mixture from the carburettor to the entry port into the gallery induction tract: the axis of entry is inclined at 135 deg to that of the vertical riser. The gallery is cored within the cylinder head; it is of almost square cross section and extends the length of the head. From it, the four individual inlet valve ports curve downwards to the inlet valves, so the mixture follows a downward path all the way from the carburettor to the inlet valves. An unusual feature of the inlet port design is that the cored ports extend to the outside of the head casting, where they are blanked with Welsh plugs. This is most convenient if the owner desires to tune his engine, since the plugs can be removed and extra carburettors fitted with little trouble.

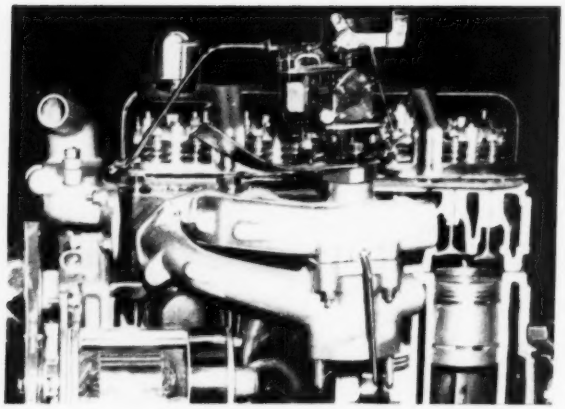
The carburettor has the standard Solex auxiliary cold starting unit, and the diaphragm type acceleration pump is mechanically actuated by a linkage from the throttle spindle. From the air intake of the carburettor, a length of large-diameter rubber hose leads upward and over to the long cylindrical air silencer, mounted on the rocker gear cover. A large oil bath type air filter is mounted low down at the left-hand side of the engine compartment, and another length of hose connects the filter with the air silencer. This use of a separate filter and silencer, with hose connections, must be more expensive than the more usual arrangement. A fuel pump of the mechanical type is fitted in a most accessible position on the left-hand side of the crankcase. The fuel supply pipes are of black plastics material.

A most interesting detail is the throttle control. This consists of a flexible multi-wire cable, thinner than the normal Bowden type, which is sheathed in a nylon tube. At the carburettor, the cable is wound round a drum attached to the

Twin Zenith 36-WIP downdraught carburettors on the Sunbeam Rapier. A cam and nylon roller mechanism operates the acceleration pump



An unusual feature of the Mercedes-Benz 220S is the metal shield to deflect the fan draught from the front end of the induction manifold



Solex downdraught carburettor installation on the Singer 1½ litre unit

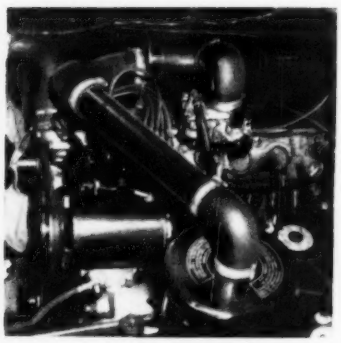
throttle spindle; also wound round the drum is a large volute type torsion spring. A most agreeable feel is given to the accelerator pedal control by the combination of the thin operating cable and the smooth, progressive action of this return spring.

On the right-hand side of the engine, the four port-branch exhaust manifold is in a rather inaccessible position; however, it should not need much attention. An unusual feature of the exhaust system is worthy of comment. The manifold has a flanged opening at each end: the rear flange is connected to the exhaust pipe in the usual manner, and the pipe leads back to the single exhaust silencer mounted towards the rear of the car. Bolted to the front flange off-take is a resonator chamber, about 10 in long × 4 in diameter. It is claimed that the exhaust gas pulsations in this resonator obviate a dip in the torque curve in the critical range of 2,000 to 2,500 r.p.m.

Also noteworthy on this engine is the use of coolant heating of the carburettor throttle body, to prevent icing. Hot coolant is fed by means of a length of small bore plastics piping from a point at the rear of the cylinder head into the throttle body coring. A length of similar pipe returns the coolant from the carburettor to the duct leading from the lower part of the cylinder block to the car heater unit.

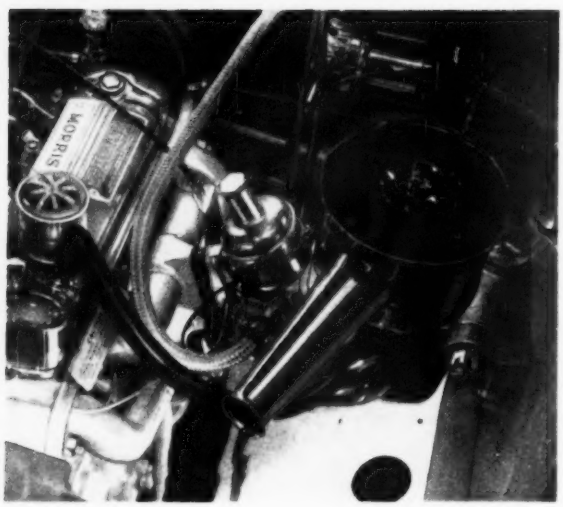
Also exhibited at Earls Court for the first time was the Facellia, a product of Facel S.A. At previous exhibitions on the Continent, this vehicle has been shown with twin carburettors, but at Earls Court it was equipped with a Solex twin-barrel downdraught compound carburettor. The car has a four-cylinder, twin overhead camshaft power unit with a bore of 82 mm and a stroke of 78 mm, the swept volume being 1,646 cm³. It is claimed to develop 114 b.h.p. at 6,400 r.p.m.

The induction manifold, mounted on the left-hand side of the engine, is of conventional form: its outer tracts sweep round to feed cylinders 1 and 4, while the inner branches curve in smaller radii to feed cylinders 2 and 3. All the tracts are large and of circular cross section. A commendable feature of the induction system is the slight rise of the gallery tracts from the carburettor region to the cylinder head ports. Fuel is supplied by a mechanical pump mounted on the left-hand side of the crankcase. On top of the carburettor intake is a circular air silencer, of shallow section, which appears to be rather small, having regard to the power output claimed.



Left: Inclined engine installation in the Peugeot 404, with the cable and drum type throttle control

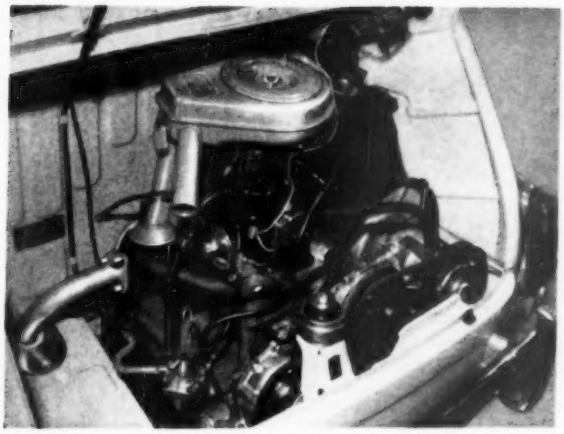
Below: Export version of the Morris Minor, showing the heater elements around the piston chamber of the carburettor and in the induction flange joint



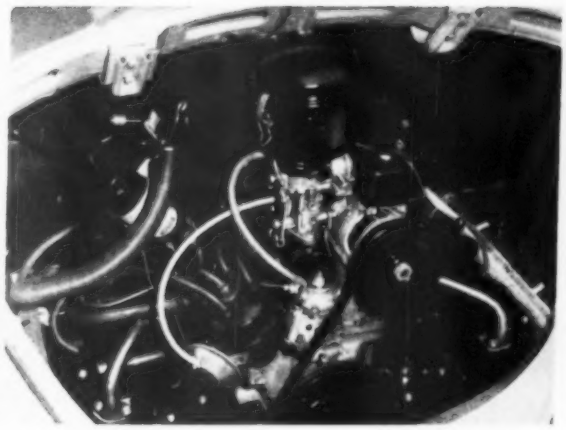
Although basically similar to earlier models, the latest Volkswagen engine has been modified to produce a little more power. The cylinder dimensions remain at 77 mm × 64 mm, giving a swept volume of 1,192 cm³, but the compression ratio has been raised from 6·6 : 1 to 7·0 : 1, and a completely different carburation system has been adopted. A Solex 28-PICT carburettor is now employed, and this instrument represents a radical departure, since it incorporates an automatic choke of the American pattern, complete with off-set strangler valve, vacuum kick piston, automatic fast idle linkage cam, and electrically heated thermostat element. To prevent icing, the emulsion system is buried in the main body of the carburettor, and its discharge passage takes the form of a small inclined tube leading down into the venturi. Also included in the carburation system is a diaphragm type acceleration pump of the usual Solex design.

Another departure is the abandonment of the use of a centrifugal control for the ignition automatic advance and retard. Instead, the ignition timing is now regulated only by harnessing engine suction, in the manner employed on some American engines. Suction channels are taken from both the waist of the venturi and a point adjacent to the almost closed position of the throttle valve. Suction from these points is imposed upon a diaphragm system, which moves the ignition distributor to provide the appropriate timing.

Possibly the most ingenious feature of the new Volkswagen engine is the automatic control for admitting heated air to the carburettor, to prevent icing and to provide warm air for economical operation in cold weather. Two sources of carburettor air are available: one is the air cooling duct, from which warm air is supplied, and the other—which provides colder air—is the engine compartment. Control is effected by a simple metal flap valve in the tract. Since this valve is held in the closed, or warm air, position by a light counterweight, the engine inhales the heated air when operating under light load. At wider throttle openings, the suction on the valve causes it to open, letting cold air pass to the engine. The air valve can readily be locked, by a simple clip, in either the open or the closed position, according to requirements.



In the Fiat 600D engine installation there are two intakes to the air cleaner. One is open to the engine compartment and the other has a flared end immediately over the exhaust manifold. A simple lever control on the air cleaner is employed to direct the air in through one or other of these intakes, according to seasonal climatic requirements



With regard to their new downdraught carburettor for the latest version of the Volkswagen engine, Solex have departed from their normal practice in that the automatic choke is of a type similar to that used on American cars: a thermostat spring actuates the strangler spindle, and heat is supplied by an electric element that is installed in its housing

Continental car manufacturers appear to be far more conscious of the value of an optional warm air supply to the carburettor than do their British counterparts. Most Fiat models have this feature, although not in the automatic form employed by Volkswagen. On the Fiat 600D, for instance, the change from cold to warm air, or *vice versa*, is made manually by operating a lever connected to a simple flap valve, in the air intake to the carburettor. The Fiat 1800 and 2100 models have a similar scheme.

Many engines equipped with downdraught carburettors are fitted with a drain pipe in the floor of the induction manifold, to carry away any excess fuel that might be present because of flooding or vapour pressure. On the Fiat 600D, however, there is a most unusual arrangement. Instead of the drain pipe being taken from the floor of the manifold tract, it is taken from a recess around the top of the riser flange.

Although the Singer Gazelle was previously fitted with twin Solex downdraught carburettors, it now has a single 32 mm downdraught instrument of the same make. The induction manifold is of the twin-gallery design similar to that employed on the Hillman Minx. An effective hot-spot is provided at the point where the induction and exhaust castings are together, one above the other. To obtain adequate exhaust heat at the required spot, a metal deflector plate, clamped between the faces of the castings, causes exhaust gases from the medial exhaust ports to be directed upwards against the floor of the induction tract.

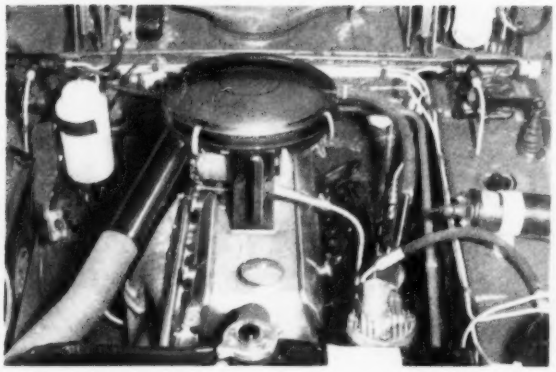
The Hillman Minx series 3B is fitted with a Zenith 30-VN instrument, whereas the previous model, the series 3A, was equipped with a single Zenith 30-VIG carburettor. This instrument now employed is one of the recently introduced range of short carburettors, especially designed to fit snugly under a low bonnet. In basic design it is similar to the well known V type but, to keep the metering elements cool and so retard vapour formation, the emulsion block is suspended inside the float chamber and is therefore immersed in fuel. An automatic economy system, for low fuel consumption during part-throttle running, is incorporated, as is a mechanically actuated acceleration pump. The induction and exhaust manifolds are similar to those employed on the series 3A Minx, described in last year's review.

In a Show decidedly lacking in engine novelty, the new Standard six-cylinder power unit aroused a great deal of interest. The bore and stroke of this engine are 74·7 mm and 76·0 mm respectively, giving a swept volume of 1,998 cm³. This figure is slightly smaller than the corresponding one of the existing four cylinder unit in the form employed in the Vanguard car.

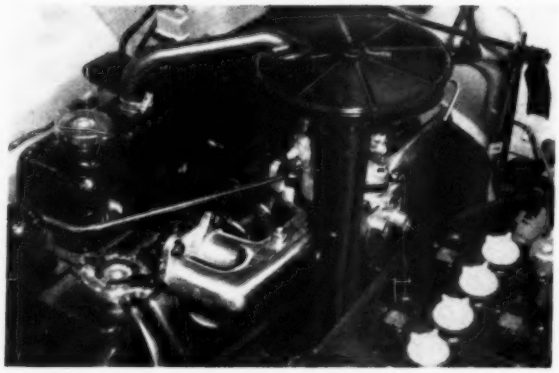
This engine is particularly interesting in that it is the first to be fitted with an entirely new type of Solex carburettor. This carburettor, of which two are installed, is of the semi-downdraught type, has the designation 32-PIH, and is designed to fit under a low bonnet. The air intake is a short vertical tract, as in the conventional downdraught carburettor. Also, the emulsion system, which follows current Solex design, is vertical. A main jet supplies fuel to the vertical air bleed arrangement, embodying a central air tube and an air jet at the top. However, the main air passage bends through 45 deg, so that the angle between the vertical air intake and the venturi and throttle barrel is 135 deg. A single spray nozzle, instead of the rose type, points obliquely downward into the venturi, below which the carburettor design again follows the company's normal practice. To minimize sensitivity to changes of attitude, twin floats are employed, one to the front and the other to the rear of the air passage. A diaphragm type acceleration pump is situated externally on the side of the instrument; for cold starting, a starter valve of the conventional Solex pattern is mounted on top of the throttle body.

A Solex twin-barrel compound downdraught carburettor is employed on the Facellia, and it is mounted on a cast aluminium induction manifold, from which the four port-branches are taken separately

The induction and exhaust manifolds are on the right-hand side of the engine, the former above the latter, in the usual manner. A six port-branch layout has been adopted for the



As on the Borgward four-cylinder unit, the induction system of the new six-cylinder engine is enclosed completely within the rocker cover. A Solex twin-barrel compound downdraught type carburettor serves the induction manifold, the six port-branches of which are vertical



Surprisingly, Vauxhall have reverted to the employment of adjacent exhaust ports on their new Velox engine, but the thermostatically controlled hot-spot is retained. The carburettor is a Zenith 42-VNT unit, which is a larger version of the instrument previously featured

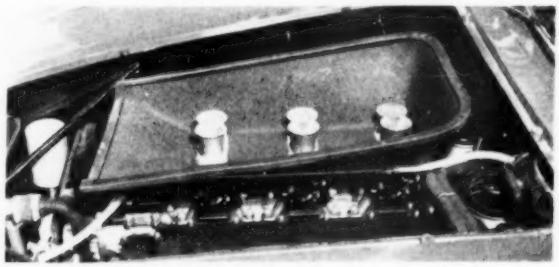
induction manifold, the branches being arranged in three adjacent pairs. The sequence of porting, from either end, is as follows: one exhaust, two induction, two exhaust, two induction, two exhaust, two induction, and one exhaust. All the galleries and port-branches of the manifold, which is an aluminium casting, are of circular cross section throughout their lengths.

Surprisingly, the carburettors are not so mounted as to feed directly into the main gallery, but are perched on top of risers, which are about 3 in high and bend outwards to bring their carburettor flange faces at the necessary angle of 45 deg to the vertical, to match the inclination of the carburettors. The manifold design shows evidence of careful thought, and the upward inclination of the gallery on each side of the riser junctions is a sensible precaution against flooding when the engine is started in very cold conditions. These junctions between the risers and the gallery are thus the lowest parts of the tract, and from them two manifold drain pipes lead into a single down pipe.

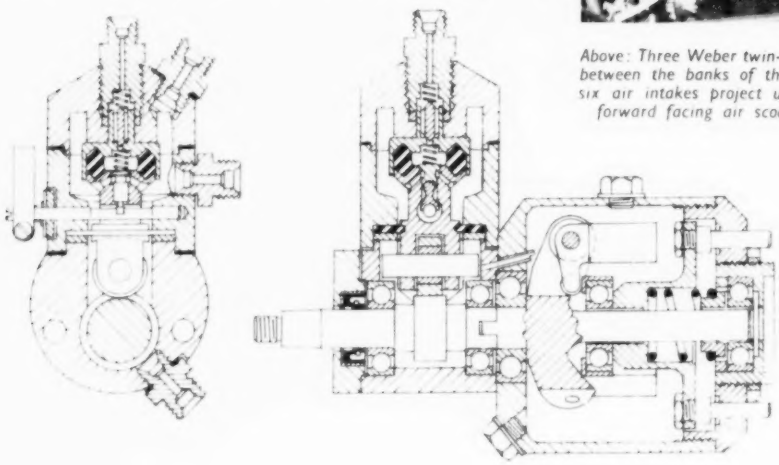
An exhaust heated hot-spot is provided under each carburettor, where mating faces on the induction and exhaust manifolds are bolted together. Heat insulating gaskets, about ¼ in thick, are interposed between the carburettors and the induction flanges. A short rod interconnects the two throttle spindles, some degree of flexibility being obtained by the use of loop type spring steel connections. A combined air silencer and paper-element cleaner of generous proportions surmounts an airbox—fabricated from sheet metal—which, in turn, fits over the air intakes of the carburettors. Fuel is supplied by an AC mechanical pump, on the left-hand side of the crankcase.

Another newcomer is the Borgward Big Six. This is an engine of 2,240 cm³ swept volume, with a bore and stroke of 75 mm and 84·5 mm respectively. As on the Isabella four-cylinder model, the induction manifold is inside the rocker cover, and is bolted down on to a horizontal face on top of the cylinder head. The tract is served by a Solex twin-barrel downdraught 32-PAJTA carburettor with compounded throttles. It has six vertical inlet port-branches—an arrangement that should result in excellent filling. A circular air cleaner of shallow dimensions surmounts the carburettor, and from it a single silencing tube projects forward to an opening by the side of the radiator.

Notable among the new six-cylinder engines is that of the Vauxhall Velox and Cresta cars, which has square bore and stroke measurements of 82·55 mm; its swept volume is 2,651 cm³, as compared with the 2,262 cm³ of the earlier unit.



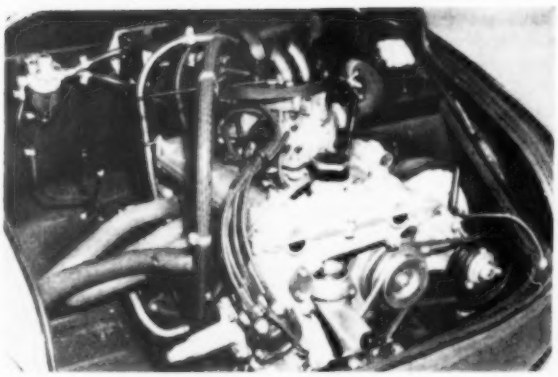
Above: Three Weber twin-barrel downdraught carburettors are mounted between the banks of the Ferrari Berlinetta V-twelve engine. Their six air intakes project upwards into a large chamber served by a forward facing air scoop that is incorporated in the bonnet top

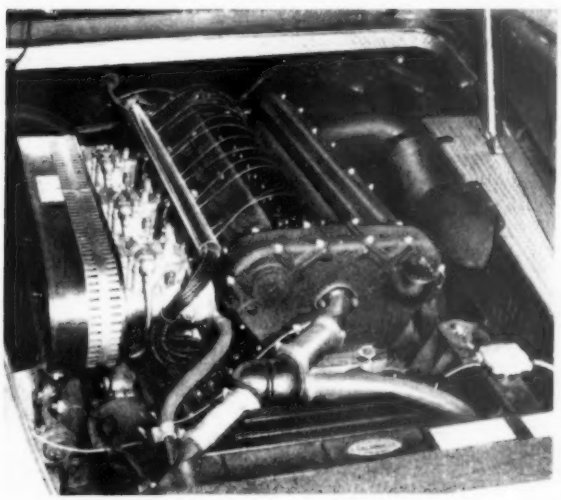


Longitudinal and cross sections of the Simms petrol injection unit. The fuel is ejected from the inner chamber by upward movement of the plunger and also by the bulging of the synthetic rubber ring between the plunger and the upper end of the chamber

Surprisingly, on this latest engine, a return has been made to the pairing of the inlet and exhaust ports, instead of the alternate arrangement employed on the previous six-cylinder model, and indeed also on the Victor four-cylinder engine. It is claimed, however, that the circulation of water around every cylinder bore and port tract provides adequate cooling of the exhaust ports and valves.

Instead of the bath tub combustion chamber previously employed, the new engine has a chamber of wedge form, with a large squish area opposite the sparking plug, the valve stems being inclined slightly away from the plug. The porting arrangement along the side of the cylinder head is now: one exhaust, two inlets, two exhausts, two inlets, two exhausts, two inlets and one exhaust. In consequence, the induction manifold which is of the straight rake form, has three relatively closely spaced pairs of normal port-branches.





Above: An unusual carburettor arrangement has been adopted on the Abarth 1000: the Weber four-barrel downdraught instrument is mounted between the twin camshafts with its principal horizontal axes at 45 deg to that of the crankshaft of the engine, and separate air tubes lead from the induction silencer to the four barrels of the carburettor

Left: Maserati engine, with three Weber twin-barrel carburettors

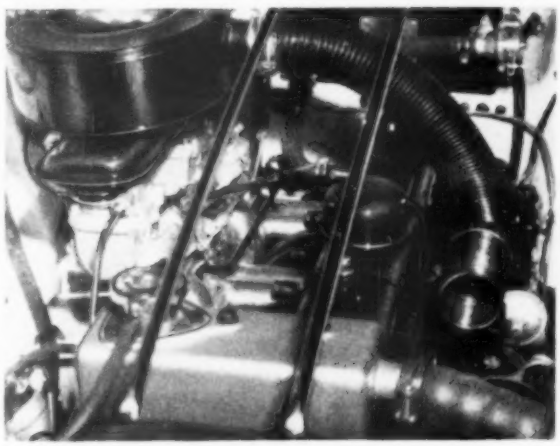
Below: Twin Solex 32-PIH semi-downdraught carburettors on the Standard Vanguard six-cylinder engine; the long risers curve upwards and outwards

Replacing the Zenith 34-VNT carburettor employed on the earlier model, a single downdraught 42-VNT instrument is now fitted; this carburettor is one of the later Zenith units, and is considerably shorter than its predecessors. It is of the non-percolating pattern, and incorporates an acceleration pump of the piston type, and an automatic control for part-throttle economy. In addition, it is equipped with an automatic choke, in which heated air from a small stove on the exhaust manifold is drawn over the coiled thermostat spring that governs the strangler position. An automatic fast idle cam system is also incorporated.

From the carburettor, the mixture passes down into the long induction gallery, the cross section of which is rectangular, but with rounded corners. On leaving the riser, the branches rise steeply before levelling out at the head joint face: this is a good feature in respect of cold starting. The induction ports in the cylinder head are circular in cross section, and rise slightly from the joint face, before curving downwards to the inlet valves. Following conventional practice, the exhaust manifold is beneath the induction component, and the two castings are bolted together in the middle. In common with previous Vauxhall models, a thermostatically controlled hot-spot is employed. In this arrangement, a sheet metal flap valve, mounted on a horizontal stem, directs hot exhaust gases up and around the induction riser and gallery junction when the engine is cold; when the engine is hot, however, the gases are deflected down into the exhaust pipe. A small coiled thermostat spring on the end of the flap valve spindle controls the valve position. Instead of the counterweight being located on the flap valve spindle, as is usual, it is now attached to the flap valve itself. Surmounting the carburettor is an AC air filter, of the shallow chamber type, fitted with an inclined silencing tube.

Certainly one of the most intriguing power units exhibited, the Ferrari Berlinetta is a V-twelve engine, with a bore of 73·0 mm and a stroke of 58·8 mm, giving a swept volume of only 2,953 cm³. Mixture is supplied by three Weber 36-DCL3 twin-barrel downdraught carburettors between the two banks of cylinders. Each throttle barrel feeds a small aluminium tract which is siamesed fore and aft. Thus, the left-hand throttle barrel of the front carburettor supplies cylinders 1 and 2 on the left bank, while the right-hand barrel feeds the first two cylinders on the other bank, and so on along the length of the engine.

A noteworthy detail of this engine is the well made and substantial throttle control layshaft system: the throttle spindles of each carburettor are geared together. Also of interest is the large plenum chamber surrounding the carburettor intakes; this chamber is fed from a forward-facing grilled slot in the front of the bonnet lid. It is notoriously difficult to achieve the satisfactory functioning of forward-facing air chambers of this kind, and the unusually large



capacity of the unit employed is doubtless the result of much development work. The chamber takes the form of a bath-shape vessel, the top edge of which is inclined downwards from rear to front, to match the sloping bonnet. It is thus much deeper at the rear than at the front. The top edge of the air chamber carries a plastics sealing strip, so that, when the bonnet is closed, the whole chamber is sealed, except of course the intake slot, through which incoming air must pass.

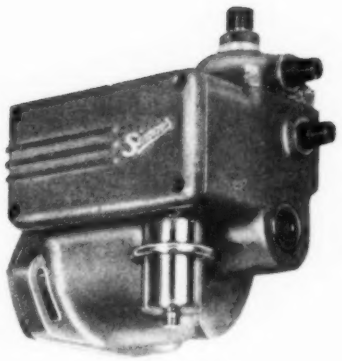
Petrol injection

The only exhibited vehicle equipped with petrol injection was the Mercedes-Benz 300SL car. This has the six-plunger injection pump, as distinct from the two-piston system exhibited last year on the 220SE model. Indeed, the 300SL remains the only car to be fitted with petrol injection as standard equipment. During the last few years there has been a marked decrease of interest in petrol injection generally. Some fifteen years ago, certain prophets foresaw the use of petrol injection as a panacea for all fuel system troubles. Although much time and money have been spent since then on development, a cheap and thoroughly satisfactory petrol injection system has yet to go into production. About four years ago Chevrolet brought out the Bel Air model, fitted with the Rochester injection system. It did not prove to be a success, and has now been discontinued. This form of injection is, however, an optional extra on the Corvette sports car.

In the light of this reversal of the earlier trend, there is some interest in the introduction, by Simms Motor Units Ltd, of a petrol injection system of unusually simple design. This system comprises a pump, an injector nozzle and a control arrangement that adjusts the fuel delivery rate to suit the operating conditions. The pump is of the timed delivery type and the injector nozzle is fitted in the manifold, immediately downstream of the butterfly type air throttle.

As can be seen from the accompanying illustration, the pump is basically of the plunger type. The plunger is actuated by a camshaft which, in the case of a four-stroke engine, revolves at half engine speed and has one lobe per cylinder. Petrol is fed by a lift pump or gravity to an annular outer chamber surrounding the pump element. When the plunger

Twin S.U. semi-downdraught carburettors on the Riley 1½ litre engine



The new Simms injection pump unit, the longitudinal and transverse sections of which are illustrated on one of the preceding pages

is at the bottom of its stroke, the poppet type inlet valve in the upper portion of it is open and petrol flows through this valve into the inner chamber above the plunger.

The initial upward movement of the plunger causes the inlet valve to close and so seals the inner chamber. Further upward travel of the plunger causes displacement, or bulging, of the inner wall of a specially shaped synthetic rubber ring, which is fitted between the plunger and the upper end of the inner chamber. This deformation of the ring results in the rapid discharge of the petrol from the chamber through the non-return valve above it, and so into the fuel line to the injector nozzle.

Metering is controlled by means of an eccentric shaft carried in bearings in the pump housing. As can be seen in the illustration, the shaft passes through the middle of the plunger assembly. When it is rotated, it varies the exact moment at which the inlet valve closes under the influence of its return spring. Thus, by regulating the amount of fuel that spills back into the outer chamber as the plunger begins to rise, it varies the effective stroke of the pump.

The camshaft housing is fed with oil, which is prevented from reaching the metering unit by a simple diaphragm type seal between the plunger and its housing. Vapour lock in the outer chamber is prevented by the provision of a continuous bleed back to the supply tank. A pintle type of injection nozzle is employed, to give a well dispersed spray of petrol into the manifold, and so to ensure thorough mixing with the air. The nozzle embodies a two-stage spring arrangement that is said to provide good atomization at both high and low rates of delivery, without the need for very high pressures.

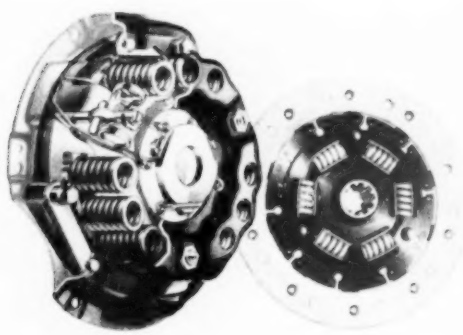
Control of the fuel delivery to suit varying conditions of engine speed and load is effected by the combination of a speed-sensitive governor and a diaphragm unit subjected to manifold depression. The governor is mounted in tandem with the pump. A manually operated over-riding control provides the necessary enrichment for cold starting. This control is released by the driver as soon as the engine has started, its function during the warming-up period being taken over by an enrichment device actuated by a temperature-sensitive element fitted in the cylinder head water jacket.

Though ingenious, and capable of being manufactured relatively cheaply, this system cannot, of course, entirely overcome the distributional difficulties inherent with an orthodox manifold. Neverthless, test results published by the company indicate considerable promise. These tests were carried out on a Renault Dauphine engine, of 845 cm^3 swept volume, in which the fuel requirements per cycle are as small as 5 mm^3. The use of the petrol injection system, in place of the standard carburettor, raised the maximum power from 27·5 to 31 b.h.p, and the b.m.e.p. from 118 to 130 lb in^2. Of perhaps still greater significance was the reduction of the best specific fuel consumption from 0·6 to 0·5 pints b.h.p-hr. Throughout the speed range, the performance and consumption figures were superior to those of the unit in standard form.

CLUTCHES

Well Known Manufacturer Introduces a Diaphragm Spring Type and Extends Range of Strap Drive Clutches; Details of a Successful Racing Design

SINCE the introduction of the Laycock-Hausermann diaphragm spring clutch at the London Commercial Motor Show in September, the Borg and Beck Co. Ltd, the primary supplier of clutches to the British motor industry, have announced and exhibited at Earls Court their new DS type diaphragm spring clutch, which will go into production in a range of diameters between 6½ in and 10 in. Two- and three-plate DS clutches for competition purposes were also on view. This diaphragm spring clutch is functional, clean, robust and simple in its basic conception, which inevitably raises a query as to why it has taken so long to become available for British cars. Conventional clutches embodying clusters of coil springs have, of course, been highly successful, although centrifugal effects on the coil springs have to be carefully assessed whenever a modern high-speed application is considered. This is because bending

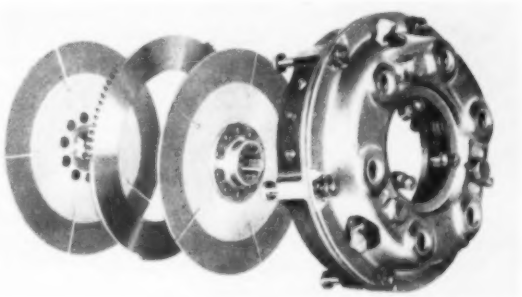


of the springs could result in a partial reduction of the clamping pressure.

The diaphragm spring layout obviates this inherent shortcoming, and in addition it is a far more balanced design, since the main components are all basically discs or rings. No toggle levers are required for disengagement because the inner ends of the diaphragm spring engage directly in the thrust member. There is good reason to believe that the diaphragm spring clutch can offer at least the same reliability and service-free life as the conventional clutch and, since even a brief examination indicates simpler production methods, it should also be cheaper to manufacture.

This type of clutch is well known in America, and it is of interest that the Goggomobil Royal T700—now available in this country—is fitted with a Hausermann diaphragm spring clutch of German manufacture. A recent improvement to this clutch is the introduction of a larger diaphragm spring, presumably of lower rate. This modified spring may be fitted to the clutches of existing cars, although it necessitates the employment of a new clutch cover pressing, a modified thrust plate and, of course, a larger snap ring to secure the spring in the thrust plate.

Basically, the Laycock-Hausermann and the Borg and Beck diaphragm spring clutches are similar, though they differ in several details. In both cases, the spring comprises the frustum of a cone, with a series of slots extending radially from the minor end, that is, the central portion. These slots terminate in holes, to prevent stress concentrations at the roots of the prongs when the spring is deflected. On the Borg and Beck DS clutch, bolts pass through these holes : the bolts hold together the clutch cover pressing, an inner ring and two circular section wire rings, between which the diaphragm spring is sandwiched. It has been found convenient to utilize these bolts for the radial location of the wire rings, since this ensures coaxiality of the assembly, uniform stressing of the spring, and balance.

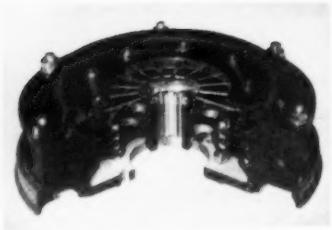


Above: The Borg and Beck 7½ in twin-plate clutch for Grand Prix, sports and other racing cars. These units feature sintered facings. Left: Although the Borg and Beck strap drive clutches were initially introduced for commercial vehicles, they are now being applied to cars

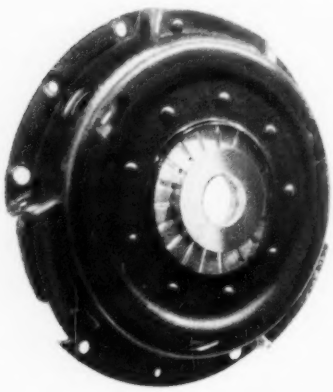
A projection on the pressure plate abuts against the major end, that is, the outer periphery, of the spring. When the cover and spring sub-assembly is bolted to the flywheel, in the conventional manner, the thickness of the clutch plates and pressure plate is greater than the axial distance between the clutch cover flange and the periphery of the spring. Hence, the height of the cone frustum must be considerably reduced before the clutch is finally assembled. It is this flattening of the diaphragm spring that causes axial thrust to be exerted on the pressure plate. Since the spring is clamped between the two wire rings, and the spring periphery is in contact with the pressure plate, the wire rings act, in fact, as a kind of annular fulcrum about which the spring deflects.

The thrust ring bears on the inner or minor end of the spring. When pressure is exerted by this thrust ring, the cone flattens still further until the periphery of the spring no longer contacts the pressure plate, and the clutch is in the disengaged position. This action is extremely simple, because release toggle levers, fulcrum pins and adjusting devices are not needed. From the manufacturer's point of view, it is possible to vary the clutch characteristics by means of differently shaped spring diaphragms of various thicknesses as well as by the length and number of prongs into which the minor end of the spring is divided.

Any of the currently used clutch plates, with or without cushion centres, could be used in the diaphragm spring type clutches, in much the same way as in the conventional assemblies with coil springs. There is, of course, no limitation as to the type of clutch lining that may be used, and



This new Borg and Beck diaphragm-spring type clutch with three 7¼ in diameter plates, for competition cars, is sectioned to show the general arrangement



Complete assembly of the Borg and Beck diaphragm spring type of clutch, which is compact, has relatively few components, good inherent balance and the performance of its spring is unlikely to be adversely affected by the centrifugal force

refinements such as a strap drive can be incorporated in the design. One advantage claimed for the strap drive clutch, to which further reference will be made later, is that the absence of rubbing contact between the pressure plate and the cover eliminates the possibility of squeaks and rattles.

Noisy operation is, of course, undesirable in any clutch and, in the new diaphragm spring units, a certain amount of movement between the spring and the wire rings supporting it is unavoidable during clutch engagement or disengagement. Should any foreign matter become lodged in this region, it might form a possible source of squeak during clutch actuation. Undoubtedly this question has been carefully considered during the development of these clutches, particularly because the cover pressing, owing to its simpler configuration, may be more capable of magnifying any irritating noises than is one of conventional design.

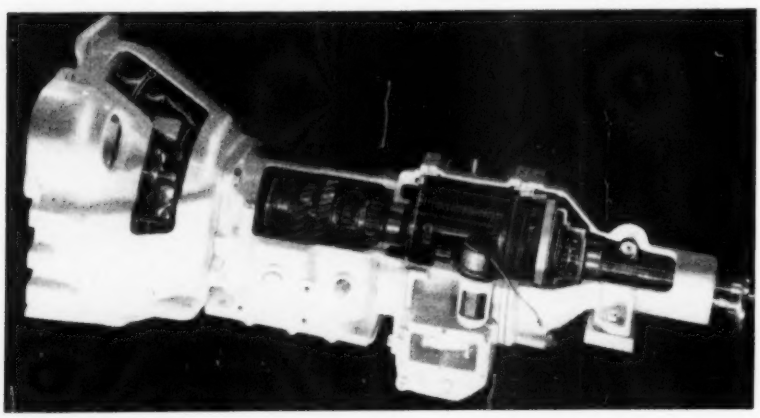
Taking into consideration the vast experience and knowledge that has made the normal clutch so quiet and reliable in operation, there is little doubt that the diaphragm spring units will be at least as good and efficient, besides being perhaps a little cheaper to produce. Their basic design renders them suitable for a wide variety of applications and so should make them as successful as the more orthodox type. Certainly they are a valuable contribution to progress in automobile engineering.

Reference was made earlier to the strap drive type of clutch, which has proved very successful on commercial vehicles. The Borg and Beck Co. Ltd. has now extended the strap drive range into the car field by introducing the AS series. An 8·5 in diameter example from this series is included in the accompanying illustrations. It has a maximum torque capacity of 140 lb-ft, and is suitable for speeds of up to 7,000 r.p.m.

As the designation implies, the torque is transmitted from the clutch cover to the pressure plate by three pairs of tempered steel straps: each strap is riveted at one end to the clutch cover, and the other end is bolted to the pressure plate. These straps provide a tangential drive for the pressure plate; they can deflect in an axial direction as the clutch is released, while maintaining the concentricity of the pressure plate, and therefore the balance of the assembly, over the full range of clutch lever movement.

The operating conditions of the clutches of Grand Prix and sports racing cars are becoming ever more severe, as power outputs rise and handling qualities are improved. Cars of these types require compact, highly rated clutches of relatively small diameter, to keep down the inertia of the rotating masses. One exhibit was the 7½ in diameter twin-plate clutch fitted to the Cooper formula 1 racing car with which Jack Brabham gained the world championship for the second year in succession. The clutch used on the Cooper, and on the rival Lotus cars, has a maximum torque capacity of 230 lb-ft and is suitable for engine speeds of up to 8,500 r.p.m. It is interesting to compare this unit with the new AS clutch just mentioned, which was designed for unusually high speeds for production type engines. The comparison is indicative of the contribution made by motor racing to the development of the modern car, for it appears likely that engine speeds will continue to rise.

The two plates of this racing car clutch have friction facings of a sintered material, and their combined inertia is less than that of a single-plate clutch of equal capacity, a feature that facilitates extremely rapid gear changing. On some racing clutches, the plates have a number of sintered pads rather than the solid facing shown. It is of interest that rigid plates are used in racing clutches instead of the conventional type with cushion drive centres. This would seem to be a case of choosing the lesser evil, since lack of torsional flexibility is often a source of trouble in cars having both the engine and the drive at the rear or the front. With regard to the arduous duty which a racing car clutch has to perform, it has been estimated that a driver makes well over 2,000 gear-changes during the Monaco Grand Prix, a figure that is all the more remarkable since most of these changes are effected at high engine speeds.



Three different transmissions are available for the Vauxhall Velox and Cresta cars. That on the left is the manually controlled three-speed gearbox together with the Laycock-de Normanville A type overdrive unit. The other two transmissions are illustrated together on the opposite page

Transmissions

Significant Progress Made in the Development of Automatic Systems for Engines of Medium Size and Even Smaller

ANOTHER milestone on the road to the general adoption of automatic transmissions was reached recently, when the General Motors Corporation introduced a small version of their Hydra-Matic system. This latest unit, the 61-05 model, is available for Vauxhall, Opel and Holden cars, as well as for certain of the Corporation's cars made in America. Undoubtedly, basic economic considerations, as well as the peculiar needs of American compact cars, must have had a strong influence in deciding where this new transmission is to be produced. Irrespective of the merit of the design, it is a tremendous tribute to American production techniques and ability that, in Britain, this transmission will cost only £120 extra, plus £50 purchase tax. A shrewd estimate of the probable number of transmissions that will be required, together with a keen appreciation of scientific production methods, must have played their part in arriving at this realistic and competitive price. In all, the Hydra-Matic 61-05 unit, as an automatic transmission thoroughly practicable for cars in the upper-medium size category and imposing a weight penalty of only 30 lb, is a remarkable feat of engineering. This was the only really new transmission exhibited at the 1960 London Motor Show, for the interesting Pontiac Tempest—with its transaxle layout—was regrettably absent from Earls Court.

In view of the fact that at least six other automatic transmission systems are being developed in this country, particularly for the smaller type of car, it is pertinent to reflect upon the qualities of at least some of those at present available in Great Britain. One well-entrenched misconception, which is about to be disposed of, is that such transmissions are only suitable for or acceptable on large automobiles.

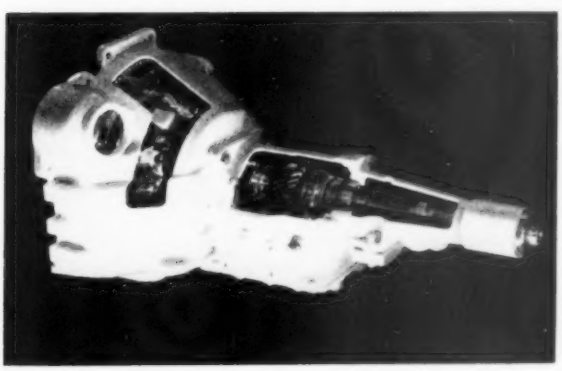
Borg-Warner transmissions are available on at least 25 different makes of car and the company's penetration into the European car industry is indeed a considerable achievement. The Smiths Easidrive transmission, available on the Hillman Minx and Singer Gazelle, seems to please many drivers of these Rootes Group products, and the Hobbs Mecha-Matic transmission is now being offered by Borgward as an optional extra. Rolls-Royce Ltd. has long catered for the specific requirements of its cars and customers with a much modified version of an earlier type of Hydra-Matic transmission. On view at Earls Court was a beautifully sectioned DAF transmission assembly which, for the first time, showed all the interesting details of this belt drive design. Another Continental small car, the Goggomobil, is still available with the remarkable Getrag semi-automatic transmission.

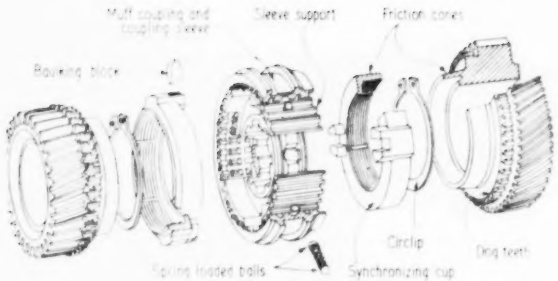
In the foregoing summary, mention has been made of automatic transmissions that could cover the entire range of production cars, if price and weight were not of over-riding importance. It is still true to say that of all the automatic systems available, and known to be under construction or test, the DAF infinitely variable friction drive is the most perfect from many theoretical considerations. Even the most experienced professional road testers admit that they have been unable to fault this transmission, although the power available from the DAF engine imposes limitations on performance. In this respect, it seems unlikely that a reasonable increase of power would cause failure, but it without much doubt would adversely affect the life of the belt.

If technical merit alone determined the success of a transmission, there is little doubt that the M.I.R.A. transmission would rank high, for it too provides an infinitely variable ratio between two limiting values. It may be recalled that it embodies two epicyclic gear trains, which are connected with the engine in such a manner that two thirds of the engine torque output are transmitted mechanically and one third by way of a hydrostatic pump-motor arrangement. This pump-motor system operates on a variable resistance principle, similar to that of the shunt of an electric motor, thereby varying the output torque and speed. The M.I.R.A. transmission is unfortunately not yet in production, nor was it shown at Earls Court, but because of its advanced conception, mention of it can hardly be omitted from a review of current transmission systems.

All the other automatic transmissions — the two Borg-Warner designs, Smiths Easidrive, Hobbs Mecha-Matic and both Hydra-Matic types—are stepped ratio transmissions, embodying highly ingenious devices to effect the changes from one gear to another. There would appear to be no

These alternative transmissions, as well as that illustrated opposite, are offered for the Vauxhall Velox and Cresta models. That on the left is the manually controlled three-speed unit and the other is the new G.M.C. Hydra-Matic three-speed automatic transmission to be manufactured in the U.S.A.





The ZF synchronizer unit, as used in the Lotus Elite Series II coupé

limit to the scope for the exercise of skill and talent in the design of the control systems of these transmissions. Most are sensitive to engine and road speeds as well as throttle position, besides incorporating over-riding manual control devices. Oil pressure and hydraulic valves are favoured for the actual gear shifting, but electronic devices have been experimented with in Great Britain. The possible intricacy of a control layout is adequately illustrated by one American transmission examined a short while ago: it was found to contain over 30 hydraulic valves and a large number of springs and other components. The gasket between the gearbox casing and the control valve unit bore a startling resemblance to the printed circuit of some complicated electronic equipment.

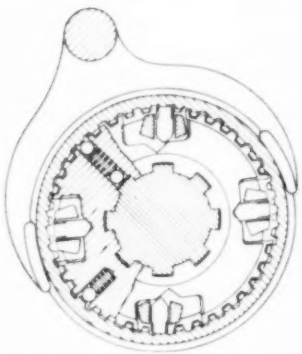
In the case of the stepped ratio automatic transmissions, complexity and cost are the principal obstacles to their introduction on cars in the 750 to 1,300 cm³ class. The still prevalent belief that efficient hydrokinetic torque converters cannot be made economically to suit engines of this size may be dispelled by one or two current developments yet to be announced. It would be interesting in this connection to examine the torque converter which is fitted to the Mazda R-360 car produced in Japan, which has an engine capacity of only 356 cm³. Mention should also be made that, several years ago, an apparently satisfactory torque converter transmission was developed in Italy for a scooter having an engine of only 175 cm³. However, because of its excessive cost and weight it was never put into production.

Hydrokinetic couplings, on the other hand, can readily be produced for any size of car and engine. Hence, there would appear to be no profound technical reasons why the Hydra-Matic 61-05 transmission should not be made suitable for cars with much smaller engines than the new Vauxhall Velox and Cresta units, which have a swept volume of 2,651 cm³. A direct comparison of the gear ratios of the alternative Vauxhall transmissions is interesting but must be regarded with caution, because the reasons for the differences have not been stated and can, therefore, only be assumed. These ratios are:

	Third	*Second*	*First*
Standard	1:1	1·635:1	2·866:1
Hydra-Matic 61-05	1:1	1·58:1	3·03-3·64:1

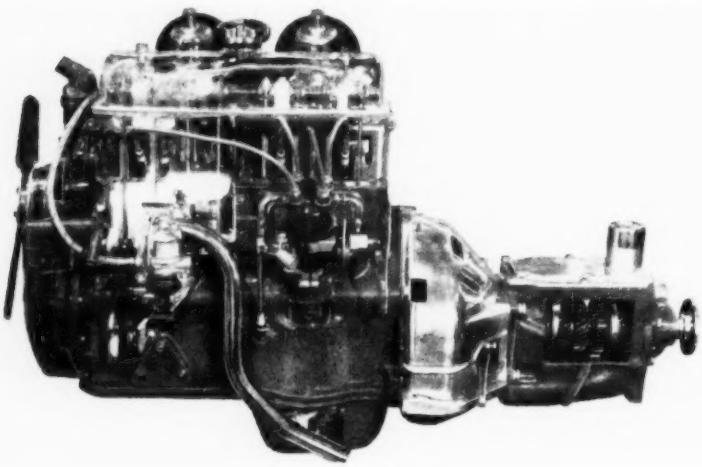
The alterations to the intervals between the ratios may indicate a desire to improve the maximum acceleration from a standing start, while maintaining satisfactory fuel consumption in normal driving.

It is to be hoped that the changes due to the increase of engine size and adoption of the new transmission will not have dramatic effects on the final drive unit and half shafts. These changes have increased the maximum output torque of the transmission by a total of 46 per cent: of this, 19·2 per cent is due to the larger engine and 5·5-22·5 per cent due to the stalling torque ratio of the transmission. It would be interesting to compare the tractive effort and power curves of a car fitted with the orthodox clutch and three-speed gearbox with those of one equipped with the Hydra-Matic unit, since the evidence suggests that the new transmission should provide a vastly different, if not actually superior, performance. Nevertheless, it seems a pity that overdrive has not been incorporated in the 61-05 system, as this would increase its attraction to the more discerning motorist.



Cross section of the ZF synchronizer unit. The baulking pieces diametrically opposite one another in the vertical plane are shown baulking the engagement, while those in the horizontal plane are in the position they assume when the gear is engaged

The Hobbs Mecha-Matic and the Smiths Easidrive stepped ratio transmissions can be fitted to practically any size of car, if price and a small penalty in respect of size and weight are not obstacles. However, at least one hydrokinetic transmission without these disadvantages is being developed.



Neat assembly of the Volvo engine and orthodox synchromesh gearbox. Possibly the reason for not having a long extension on the rear of the gearbox is that it would take a long time to become warm after starting in the Swedish winter months, and therefore there might be difficulties with regard to the lubrication of the rear bearing

This transmission provides an infinitely variable ratio range for all driving conditions, as well as a passing gear, or low, range engaged simply by pressing a button.

A prerequisite of this type of design is a torque converter with a high efficiency—particularly beyond the conversion range, when output torque is virtually the same as input torque—and an appreciably higher conversion ratio than is offered by most American automobile torque converters. This formidable requirement stems from the continuous use of the converter, but the complexity of gear shifting—apart from the unavoidable selection of forward or reverse—is, of course, completely absent. Because of its infinitely variable nature, this type of transmission can hardly be regarded as falling into the category of ordinary automatic gearboxes but into a superior class entirely suitable for the small and medium size car. Because of its simplicity, the price of this type of unit would undoubtedly be commensurate with the requirements for this class of vehicle.

It would be unfair not to mention the so-called split drive principle, since a car with this feature has recently been demonstrated in Britain. With this system, a hydrokinetic torque converter transmits part of the engine output, while the remainder is transmitted purely mechanically; thus, the aim is at achieving by hydrokinetic means what the M.I.R.A. transmission is intended to do with a hydrostatic unit. Strictly speaking, the device is not entirely new, but it is of interest because of the collaboration between certain French and German interests, and because it may soon reach the stage of practical comparative evaluation.

Crystal gazing can be interesting and valuable so long as it is not interpreted as predicting the exact pattern of the future; the purpose of the preceding survey is not to imply that any or all of the devices mentioned will be on next year's cars. Certainly, fresh thought is being given to the subject, and traditional practices in automobile engineering are under scrutiny, because modern traffic conditions demand that the vehicle should reduce the gap between the less proficient and the more expert motorist.

Detailed examination of the new Hydra-Matic transmission reveals a number of noteworthy features. In particular, there is considerable speculation concerning the hydrokinetic coupling, which has a diameter of only 7½ in, yet is capable of transmitting a maximum torque of nearly 150 lb-ft at 2,400 r.p.m, and 95 b.h.p. at 4,600 r.p.m. In comparison with others, this coupling appears rather small. Piston ring type oil seals are relied upon to a large extent, and the use of variable-displacement vane type pump indicates that careful attention has been paid to the minimizing of parasitic losses. The gearbox itself is extremely compact, and plain bearings are used extensively in it; however, the hydraulic control system, because of its complexity, is beyond the scope of this review.

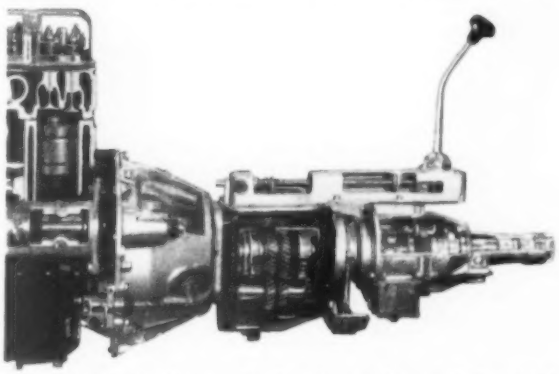
Last year, the General Motors Corporation introduced the Chevrolet Corvair, the outstanding feature of which is its rear engine-transmission unit; this car has achieved some popularity in the U.S.A. because of its excellent road holding. Now the G.M.C. engineers have produced yet another interesting experiment in space utilization, namely the Pontiac Tempest, which, unfortunately, was not exhibited at Earls Court. This car has an almost identical, combined automatic transmission and final-drive axle unit mounted at the rear, whereas the engine occupies the more orthodox, frontal position. The rear transmission group has been aptly named a transaxle.

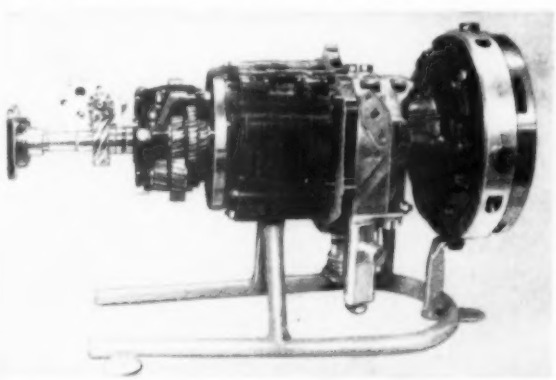
It is a great pity that American automobile manufacturers are so reticent about certain aspects of their products, while being liberal in the supply of detailed information on others. For instance, although a remarkable effort has gone into revealing the intricacies of the Hydra-Matic 61-05 transmission, it was not possible at the Motor Show to examine the technical details of cars that are now a year or more old.

There are undoubtedly genuine and valid reasons for this unfortunate state of affairs, but those engineers and potential customers who visit Earls Court seem arbitrarily to be prevented from studying the notable achievements of the American motor industry. It is perhaps no exaggeration to state that to provide the facilities for such study is one of the purposes of a motor exhibition, particularly in London where the ordinary visitor has possibly a higher appreciation of engineering achievement than elsewhere. Failure to exhibit technical features discourages engineers who regard a visit to the London Show as a pilgrimage in pursuit of knowledge.

A car with considerable appeal to the connoisseur is the Lotus Elite coupé; in its series II special equipment form, the car is fitted with a special ZF close-ratio gearbox, in place of the B.M.C. series B unit. This ZF gearbox is of largely orthodox design, and is manufactured to the customary high standards of this German company. Mention should be made, also, of its efficient baulk type synchromesh, which is applied to all four forward ratios. This synchromesh mechanism is widely considered to rank among the best yet made, and it has been well proved on private cars and commercial vehicles.

The actual baulking pieces are two lozenge-shape blocks, suitably chamfered at both ends, which project axially into the space contained by the coupling sleeve, in such a manner that relative rotation between the driving and driven members forces them outward. In this way, axial movement of the coupling sleeve is prevented until the force exerted by the driver exceeds that due to centrifugal force and to the relative rotation. At this instant, the sleeve pushes the baulking pieces radially inward and slides into engagement. Spring-loaded balls provide the necessary





Above: Laycock-de Normanville D type overdrive and four-speed transmission on the Singer Gazelle. Below: Hobbs type 1015 transmission, with the standardized hydraulic control, for the 1 litre class of car

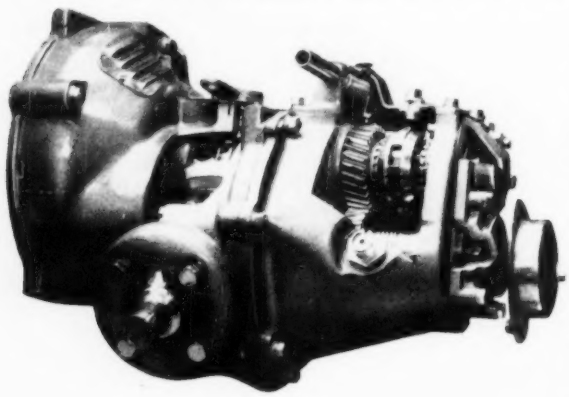
	Fourth	*Third*	*Second*	*First*	*Reverse*
Standard Elite, series II, synchromesh on upper three ratios only	1 : 1	1·32 : 1	2·20 : 1	3·67 : 1	3·67 : 1
Elite, series II, special equipment, synchromesh on all forward ratios	1 : 1	1·23 : 1	1·71 : 1	2·53 : 1	2·59 : 1

resistance for the initial engagement of the synchronizing cups.

The mechanism is refreshingly simple and, since it apparently ensures rapid and foolproof synchronization, it should enhance the already high reputation of the car. For comparison, the ratios of the B.M.C. and ZF gearboxes are given in the Table.

Indications are that Auto Transmissions Ltd, a member of the Birfield Group, has ambitious plans for the future. These plans will not, it is understood, be confined to the well known Laycock-de Normanville overdrive system, but may extend into allied fields. On the company's stand were two beautifully sectioned models of overdrive units which, of course, are manufactured by Laycock Engineering Ltd. These models were of the two available types, namely the A series, for cars in the 2 to 3½ litre class, and the D series, for smaller high-performance cars such as the Sunbeam Rapier.

Sectioned transmission unit used in conjunction with the Saab three-cylinder two-stroke engine. To obviate difficulties due to the unfavourable idling characteristics of the two-stroke engine, a roller free wheel is mounted on the input shaft; immediately behind it, but in the final drive casing, are the input-to-layshaft constant mesh pair of gears



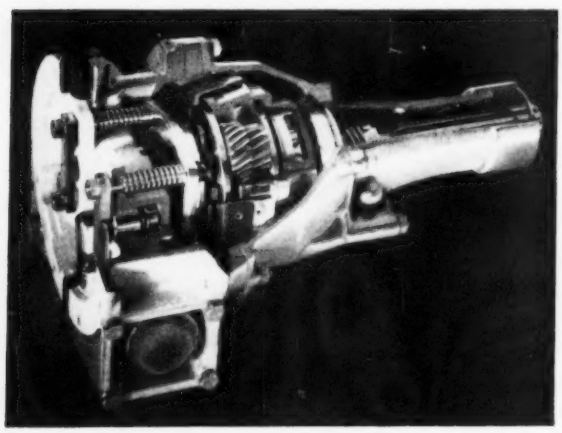
The Laycock-de Normanville D type overdrive unit, which of course is particularly suitable for small high-performance cars and is used on the Sunbeam Rapier and Alpine and also on the Singer Gazelle model

Only minor modifications have been incorporated in the Smiths Easidrive electro-magnetically controlled transmission already mentioned. These changes comprise the incorporation of a first gear holding device and a parking lock. It is worthy of note that the transmission was designed to include these desirable features, which were originally omitted as a matter of production expediency.

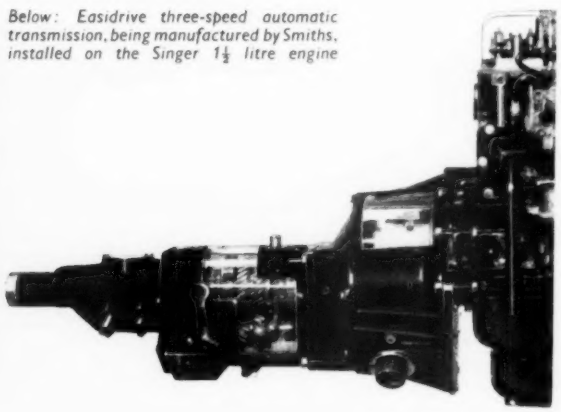
Transmission designers and gear manufacturers are probably aware of the purposeful and lengthy struggle that precedes the introduction of a new type of automatic transmission. In the case of Hobbs Transmissions Ltd, this struggle ended when their Mecha-Matic unit was adopted as an optional extra on the Isabella range of vehicles made by the Carl F. Borgward organization in Germany. The Mecha-Matic will be known as the Hansamatic in Germany and is to be manufactured by the Westinghouse Brake and Signal Co. Ltd, with whom Hobbs Transmissions Ltd. have been associated since severing their connection with the B.S.A. group.

A new version of the type 1015 Mecha-Matic unit, for engines of about 1 litre swept volume, was shown at Earls Court; it differs from the previous model in having a standardized hydraulic unit, which is interposed between the brake and the clutch cluster assembly. In addition, the clutches are slightly larger than before, and the gearing has been strengthened to make the transmission robust enough for the more powerful engines in the 1,000 to 1,100 cm^3 category. The brake unit of this new version looks far more compact than the previous model. It is to be hoped that we shall soon see a British production car equipped with this transmission, which appears to have been developed to a high degree of efficiency and reliability.

Although the N.S.U. Sport Prinz coupé is not quite new, it was shown at Earls Court for the first time. In some respects, the general layout of the engine and transmission assembly resembles that of the B.M.C. ADO 15 models,



Below: Easidrive three-speed automatic transmission, being manufactured by Smiths, installed on the Singer 1½ litre engine



though the unit is at the back and, of course, drives the rear wheels. The engine is installed transversely, and helical gears drive an extremely compact differential unit. It is easy to envisage that, even on a relatively small car like this, the space requirements of the power unit and transmission would become almost insignificant if the N.S.U-Wankel rotary engine were sufficiently developed for installation.

E.N.V. Engineering Co. Ltd. has long manufactured the combined gearbox and final-drive unit for the excellent Swedish Saab cars, which at long last are to be available in Britain. Lea-Francis Cars Ltd. made a welcome reappearance at this year's show. They have adopted an uprated Ford six-cylinder engine — as fitted to the Zodiac and Zephyr cars—to which is attached a robust Moss four-speed gearbox with synchromesh on fourth, third and second gears. Since the car also embodies a Laycock-de Normanville overdrive, it is apparent that, for a new model, it should provide an unusually high degree of mechanical reliability of the engine and transmission.

Propeller Shafts and Final Drive Units

Increasing Interest in Torsionally Flexible Couplings and Limited-slip Differentials

ONLY functional improvements have been made to propeller shafts in the past year. There is, of course, increasing competition in this field, which has led, unfortunately, to a greater reticence on the part of manufacturers to discuss future trends and possible developments. Nevertheless it was possible to establish that there is an increasing trend towards the adoption of shafts that are lubricated on assembly and sealed for life. Hardy Spicer Ltd. is producing two versions of these sealed propeller shafts, which differ in their sealing arrangements and price. It is understood that a lithium-base grease is used for packing the universal joints.

There has been more activity in the development of torsionally flexible couplings, which are becoming recognized as convenient aids in the suppression of vibration and noise emanating from the engine or final drive. These manifestations seem to be particularly troublesome where independent rear suspension is applied to a unitary structure. Although numerous types of torsionally flexible coupling have been tried, none has yet been accepted for widespread use. From the point of view of numbers produced, the most successful design is that evolved by Moulton Developments Ltd, in conjunction with the B.M.C. engineers, for fitting to the ADO 15 cars. This coupling consists of four conical rubber bushes, which are bonded to the arms of a forged steel spider. The flanges of the driving and driven members of the coupling each have two half-conical seatings, into which the rubber bushes are compressed by steel caps and U-bolts. Naturally, this type of joint has a limited torsional flexibility, but it does cater for an angular deflection of 15 deg to either side of the neutral position.

There are two unusual torsionally flexible couplings, one manufactured by Laycock Engineering Ltd, and the other by Metalastik Ltd. They provide a little more torsional flexibility than does the rubber cone type, in addition to a limited amount of axial deflection. Their virtue lies in the fact that they are applicable to existing designs, their incorporation necessitating only a slightly different or modified propeller shaft.

The Laycock TR type coupling was first shown at this year's commercial vehicle exhibition, and it was designed to effect the elimination, or considerable reduction, of body boom. This phenomenon is a high-frequency vibration believed to emanate from the engine : it is transmitted along the propeller shaft, through the transmission and final drive to the bodywork which, because of its construction, acts as an amplifier. The problem is made more intractable because of the variation between one vehicle and another; also, the vibration cannot even be identified with a particular engine speed. Besides reducing this body boom by damping the vibrations, these resilient couplings are expected to increase the life of the universal joints and of the whole final-drive assembly. Clearly, the Laycock TR coupling has been designed as a complement to the normal Hardy Spicer universal joints. It consists of two coaxial cups : the base of one of them is bolted to the flanged yoke of the propeller shaft, and that of the other is similarly attached to the companion flange of the final-drive unit or the gearbox output shaft. A rubber element is compressed into the cylindrical space between the cups. It therefore functions in shear, to transmit the torque from one cup to the other. The detail design has been so arranged that the cylindrical casing of the coupling shrouds the universal joint of the propeller shaft. A TR type coupling can, of course, be fitted at either end, or even at both ends, of a propeller shaft, but it has been found most effective at the final-drive end.

It is difficult to differentiate between this Laycock coupling and that offered by Metalastik Ltd. for the same application. The basic difference is, in fact, confined to the production technique, for in the Metalastik coupling the rubber is bonded to the cups, whereas in the TR component reliance is placed upon frictional interference.

Undoubtedly, flexible couplings of this type will play an increasingly important role in the development of the automobile, but it is as yet too early to forecast the exact manner in which the flexibility will be provided. In general engineering, there is a bewildering variety of designs ranging from the crudest simplicity to complexity and sophistication. One type, for example, incorporates air bellows, as used for certain vehicle air suspension units. On this theme, it should perhaps be mentioned that an early design has reappeared in a new guise : Silentbloc Ltd. has produced a flexible coupling disc reminiscent of the Hardy Spicer disc. This latest example is made from a special rubber mix reinforced with synthetic fibres. These discs are made with four or six bobbins, and are primarily intended for relatively light duties, as in steering systems and gear-change linkages, rather than for main transmission lines.

A very interesting and in some respects promising development is the so-called bowed rod drive of the Pontiac Tempest. Though this car was not exhibited at Earls Court, the layout is worthy of mention, since it shows originality of thought. The design appears to be based on patent number 839,292 in the name of General Motors Corporation, assignees of John Zackary DeLorean. Its purposes are the provision of a low transmission line in the region of the

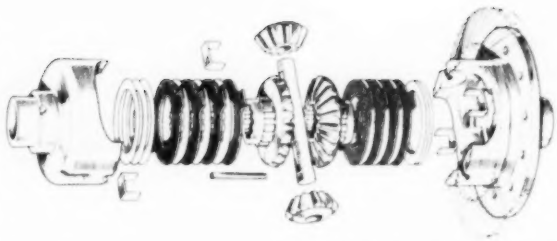
passenger compartment, and the avoidance of universal joints, because of their cost, need of maintenance and tendency to increase vibrational problems.

In this design, a solid shaft transmits the drive directly from the engine flywheel to the rear mounted transmission unit, without the interposition of universal joints or intermediate shafts. The low transmission line is obtained by bending the shaft, for which purpose it is supported in a bearing in the housing at each end, in the manner of an *encastré* beam, and also in two intermediate, steady bearings. The application of a constant couple to each end of the shaft produces a constant bending moment, and therefore stress, in addition to the stress due to the torque. However, the patent also deals with the more complex case when the bending moment in the shaft, caused by the couples at the ends, is not constant as, for instance, when these couples are not in the same plane.

Because of their curvature, shafts designed according to the patent can have a considerably smaller outside diameter than straight shafts of orthodox type, while being stiffer and therefore possessing a higher critical speed. Consideration has been given to the fact that a complete stress reversal takes place during each revolution, that is, the maximum stress is determined with the aid of SN or Wöhler curves. The mathematical problems associated with this type of shaft are known but, because of the curvature of the shaft, there must certainly be some difficulty during assembly and servicing. The simplicity of the basic conception is shown by one of the accompanying illustrations, taken from the patent specification.

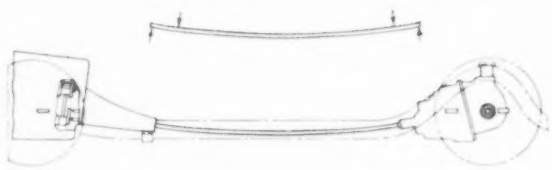
Final-drive units

Probably the most significant innovation in this sphere is the adoption of hypoid gears for the Rootes Group 1¼ litre cars, which have hitherto been fitted with spiral bevel final-drive reduction units. During the past year, no additional final-drive layouts suitable for independent rear suspension have appeared, with the exception of that employed on the Berkeley Bandit car. In fact, the final-drive unit of this car is basically that fitted to the current Ford Anglia: the axle tubes are cut off, however, and a bearing housing and a mounting bracket fitted to each side of the banjo casing. In the interest of production economy, the existing half-shafts are used: the inboard portion is cut off and each shortened component is fitted with a Hardy Spicer universal joint. Even the standard wheel hubs and brake back plates are utilized. It is rarely easy to effect a conversion of this



Above: Diagram showing the components of the Trac-Aide differential

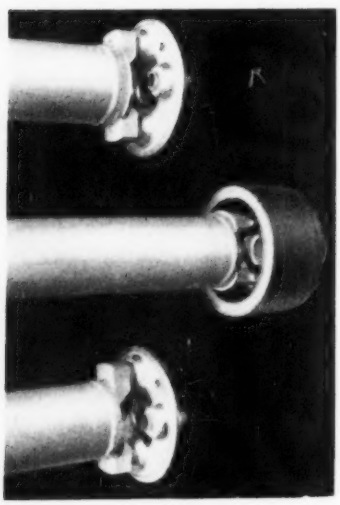
Below: Illustration showing the simplicity of the basic conception of and the forces acting on the bowed drive of the Pontiac Tempest

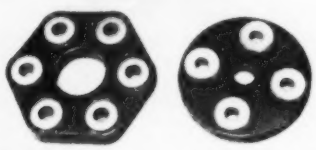


nature, and the Berkeley engineers deserve considerable credit if their ingenuity proves as successful as it promises to be.

It can be scarcely regarded as a coincidence that at least three of the available slip-limiting devices for differential assemblies are of American origin. In view of the high engine outputs resulting from the recent horse power race, some means had become necessary of ensuring a greater degree of traction, and therefore safety, even in such difficult conditions as snow, ice, sand or mud. For this purpose, Salisbury Transmissions Ltd. are producing the Powr-Lok differential arrangement, under licence from the American Thornton Axle Co. Since this device was described in the review of the 1960 commercial vehicle exhibition, published in the November issue of *Automobile Engineer*, it should suffice to reiterate only its salient features.

In addition to the conventional cross pins and bevel pinions, the Powr-Lok is fitted with two small twin-plate clutches, one behind each half-shaft gear. The cross pins of the differential pinions engage in V-form cams machined in the carrier: as load is applied, the pins move up the cams and apply pressure to the clutches, thus restricting free turning of the differential. This action provides a torque ratio between the half-shafts proportional to the friction

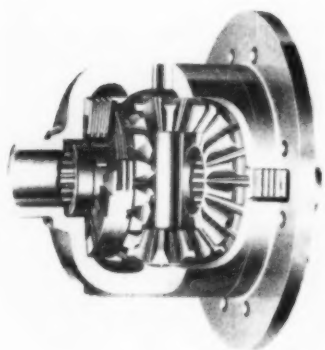




Above: Silentbloc Ltd. exhibited these flexible disc type couplings for auxiliary drives and control mechanisms. The rubber discs are reinforced with synthetic fibres

Left: Three flexible couplings produced by Metalastik Ltd. The central one is not unlike the Laycock TR type coupling; the basic difference between them is that in this instance the rubber is bonded to the cups whereas in the TR unit it is not

Below: A sectioned example of the E.N.V. Trac-Aide controlled slip differential, marketed under an arrangement with the Eaton Manufacturing Co. of America



within the differential. Consequently, the Powr-Lok normally functions in the same way as a conventional differential but, when one wheel spins, much of the torque of that wheel is transferred to the other wheel until the full traction is regained.

Another unit of this type is the Spin-Resistant differential, offered by Borg-Warner Ltd. As is the Powr-Lok, the Spin-Resistant differential is intended to overcome that inherent shortcoming of the conventional differential, namely, that the driving wheel with the smaller adhesion determines the maximum tractive effort that can be transmitted. The Spin-Resistant unit, already widely used in the U.S.A, is basically a conventional differential, but a clutch cone is installed behind each half-shaft gear. A small axial preload presses these cones into engagement with mating conical cups machined in the differential case. If one wheel slips, this static preload is supplemented by the considerably larger separating force developed between the bevel pinions and wheels of the differential. It follows that wheelspin is limited in much the same manner as with the Powr-Lok device.

Under an arrangement with the Eaton Manufacturing Co, of America, the E.N.V. Engineering Co. Ltd. is marketing the Trac-Aide differential unit. This limited-slip differential is also actuated by the separating force produced between the half-shaft gears and the differential pinions. Behind each half-shaft gear are seven clutch plates, four of which are restrained by lugs engaging in slots in the differential case; the other three plates of each clutch are splined to the appropriate gear. By means of these clutches, a drag torque proportional to the torque transmitted prevents free differential rotation between the shafts. On test, it has been found that 1·7 times the thrust of the low-traction wheel can by this means be exerted by the high-traction wheel. In order to obtain the desired axial thrust for the clutches, E.N.V. has standardized on tooth pressure angles of 22½ deg to 24 deg for the differential gears. It should perhaps be pointed out that, under normal driving conditions, the clutches assist the gears to transmit the torque to the half-shafts.

The clutch plates are specially designed to provide a consistent coefficient of friction in all conditions. All the plates are of steel, but those that are dogged to the casing have dimpled friction surfaces, the subject of a patent. The plates that are splined to the bosses of the half-shaft gears have a smooth surface on each side.

A performance comparison between a standard differential and the equivalent Trac-Aide unit, as quoted by E.N.V, is certainly interesting. Assuming a condition in which the low-traction wheel produces a draw-bar pull of 100 lb, spinning or static, the two cases give the following results:

	Pull of low-traction wheel	*Pull of high-traction wheel*	*Total draw bar pull*
Standard differential	100 lb	100 lb	200 lb
Trac-Aide differential—			
dynamic	100 lb	170 lb	270 lb
static	100 lb	350 lb	450 lb

It is claimed that, because the differential is torque responsive, the Trac-Aide has little effect on cornering behaviour. The initial cost is low, and no more maintenance is needed than on a standard differential. In principle, the Trac-Aide differential is applicable both to two-pinion and four-pinion layouts.

It should be emphasized that although all three of the slip-limiting devices just described can be built into an existing axle, new differential housings, and perhaps even different gears, are in fact required. The designs should lend themselves well to quantity production if sufficient demand were forthcoming. They offer improved traction, and consequently greater safety, for the large American cars and for the increasing number of British cars that have high power : weight ratios. Motorists who, through force of circumstances or by sporting inclination, frequently drive across country will find these devices as useful as those who have to use the roads regularly during the winter.

Suspension and Steering

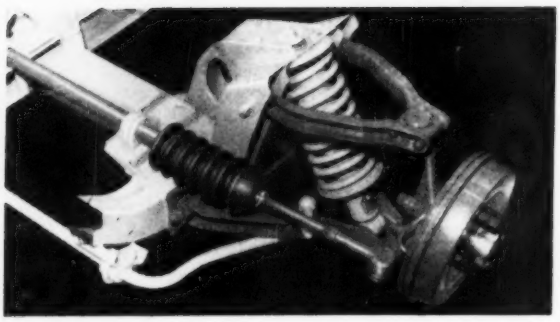
Departures from the Established Hotchkiss Drive Rear Suspension Layout, a Car with Air Suspension, and Further Development of Lubrication-free Components

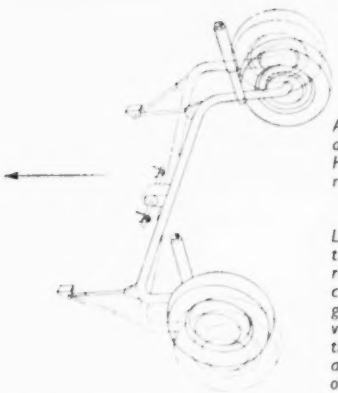
SINCE new suspension systems are generally the outcome of new car designs, and this year's Motor Show contained few new or even redesigned models, its principal interest lay outside the suspension field. The majority of the cars exhibited at Earls Court showed little novelty—rather, the continued adherence of most manufacturers to a small number of well proved systems. There were, however, a few exceptions to the general trend, as well as refinements of the established suspension systems and interesting developments in components.

In the light of the evidence presented at the Show, there can be no doubt that the great majority of car designers still favour independent front suspension systems featuring twin transverse links. There are, however, some noteworthy dissenters from the majority opinion: the new Peugeot 404 and the Berkeley Bandit have independent layouts of the strut type that is standard on the British-built Ford cars. This form of suspension is also used on the DAF 600 and at the rear of the Lotus Elite. It is interesting to note, however, that in neither the Peugeot 404 nor the Berkeley Bandit front suspension has the Ford system, of using an anti-roll bar to provide longitudinal stability of the transverse radius arm, been adopted. Instead, on both these new cars, a simple rubber-mounted drag link is used to locate the radius arm longitudinally.

A drag link of this type is also used on several cars fitted with the double transverse link type suspension. In most instances, the transverse links take the form of pressed or fabricated wishbones, of course; but on some, the lower wishbone is replaced by the simple radius arm and drag link, the two together providing an equivalent triangulation. Among the vehicles in the second category are some of the new American compact cars, such as the Plymouth Valiant, the Dodge Lancer and the Ford Falcon — which was exhibited last year but did not reappear at this year's show —as well as the Morris Minor and the B.M.C. ADO 15 models.

Still the most common rear suspension system is the rigid live axle mounted on longitudinally disposed semi-elliptic leaf springs. Although this familiar Hotchkiss drive layout, which undoubtedly possesses the advantages of simplicity and cheapness, continues to be used on the majority of cars, there are some significant departures from it. With the Hotchkiss drive system, in which the leaf springs perform the function of both axle location and springing, it is becoming increasingly difficult to reconcile the requirements





Above: The front suspension assembly of the Triumph Herald can be said to be representative of contemporary design practice

Left: Diagrammatic illustration of the layout of the rear suspension of the Saab car. Damping during roll is greater than that during vertical movements because the shock absorbers are attached at points forward of the two wheel axes

of ride and stability. Consequently, even where rigid live axles are retained, there is evidence of increasing attention being given to relieving the springs of the function of locating the axle, by the provision of separate members to perform this duty.

A good and very recent example of this modified layout is provided by the two new General Motors compact cars, the Buick Special and the Oldsmobile F-85, which have coil springs and pairs of locating arms. This approach is further exemplified by the Alfa Romeo Giulietta and the Aston Martin DB4 designs. The retention of the rigid live axle implies the disadvantages of considerable unsprung weight and of interaction between the two wheels: however, since an axle of this type is fitted on two other high-performance cars, the Maserati 3500 GT—which made its first appearance at Earls Court—and the Ferrari GT, it can be inferred that in relatively heavy cars, the ratio of sprung : unsprung weight is sufficiently high for a satisfactory ride and an acceptable degree of stability to be achieved even with leaf springs, provided that these are supplemented by a more positive means of axle location, in the form of radius arms.

On front wheel drive cars, which no longer form an insignificant minority, the rigid rear axle is somewhat less objectionable than when the rear wheels are driven. In comparison with the live rigid axle of a conventional rear suspension, the dead rear axle of a front wheel drive car can be made lighter; so the principal remaining objection is that one rear wheel still reacts on the other. Similar comments apply, of course, to rear driven cars with the dead axle of the de Dion type suspension. To obtain optimum results, irrespective of which pair of wheels is driven, independent rear suspension is necessary, but the latest example of a front driven car with independent rear suspension remains the B.M.C. ADO 15 model, which has trailing arms and rubber springs.

The Swedish Saab 96, which has front wheel drive and which was exhibited for the first time at Earls Court, retains a rigid rear axle but with some unusual and interesting features. The axle is a light, tubular U-shape beam, with the arms of the U trailing: it is pivoted in the middle, and its ends, at the junction between the trailing arms and the transverse portion, are each braced by a rubber-bushed drag link. The medial pivot is rubber bushed also, and the flexibility of the bush is such that the axle can rotate through ±7 deg about a longitudinal axis, thus regulating the roll characteristics of the suspension. Coil springs seat on pads close to and in line with the wheel axis, but the hydraulic dampers which, in contrast with the lever type of the earlier Saab models and the new estate car, are of the telescopic form, are connected to the trailing arms of the axle some distance ahead of the springs. With this arrangement, there is about 30 per cent more damping for body roll than for vertical movement, because the ratio of the distance moved by the point of attachment of the dampers to that of the axle ends is less for vertical body movement than for roll.

On the Saab 96, the independent front suspension is of the double wishbone type, embodying ball joints for the steering swivels. Coil springs form the suspension medium; the telescopic dampers are attached to the lower wishbones, and an anti-roll bar is fitted. The coil springs, which seat on the upper wishbones, have 11 coils of 11·7 mm diameter wire, in contrast to the rear springs which have 9 coils of 11·0 mm wire.

New front and rear suspension layouts

The only new British car with independent rear suspension is the Berkeley Bandit. In this model, extensive use is made of the mechanical components of the current Ford Anglia 105E, including front and rear suspension components. The primary component of the front suspension is the strut manufactured for the Anglia by Armstrong Patents Co. Ltd. These struts, which in their different sizes are the basis of the Macpherson suspension layout of all the current British Ford cars, rotate when the wheels are turned, and thus obviate the need for separate king pins.

In other respects, however, the Bandit's front suspension departs from Ford practice, for it dispenses with the anti-roll bar that provides longitudinal location in the Macpherson layout. Instead, a simple drag link is pivoted in a rubber mounting in the chassis, and it and the transverse arm together form the equivalent of a lower wishbone. The Bandit also departs from Ford practice in respect of its steering mechanism, which is of the rack and pinion type.

The independent rear suspension of the Bandit represents an interesting and ingenious transformation of the 105E rear axle into a swing axle layout. Reference is made earlier, in the section on final-drive units, to the manner in which the necessary modifications have been made, and now the description of the suspension arrangement is as follows. Two oblique arms on each side form a wishbone that locates the wheel and serves as a swing axle. The pivots of the two arms are spaced well apart and are on a line passing through the centre of the half-shaft universal joint; provided that there are no inaccuracies, the joints therefore carry torque loads only. Springing of the rear wheels is effected by long coil springs embracing coaxial telescopic dampers. The lower attachment points of the springs are close to the wheels.

Apart from the Berkeley Cars Ltd, with their Bandit, no other British manufacturer of rear driven cars has yet followed the lead given last year by the Standard Motor Co. Ltd, with the independent rear suspension, of the swing axle and transverse leaf spring type, on the Herald. The new Leaf-Lynx roadster of Lea-Francis Cars Ltd, who have resumed the manufacture of cars after a break of several years, has a conventional rear suspension incorporating long reverse-camber semi-elliptic springs with four leaves; Harrisflex rubber bushes are fitted in the spring eyes and

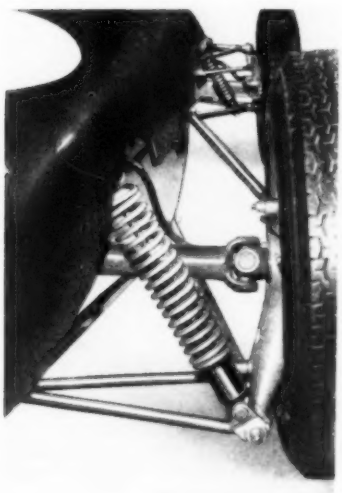
shackles. At the rear, suspension dampers of the Armstrong lever type are employed.

The independent front suspension of the Leaf-Lynx is similar to that of the Lea-Francis Eighteen and 2½ litre cars of about ten years ago. It consists of unequal-length wishbones, longitudinally mounted torsion bar springs, and Armstrong telescopic dampers. The lower wishbones are carried in rubber bushes on the front cross member, and bosses extending rearwards from the lower wishbones accommodate the splined leading ends of the torsion bars. At their rear ends, the bars are mounted in an adjustable anchorage attached to the chassis frame. In addition to those just mentioned, rubber bushes are also used at the other pivot points, with the exception of the steering swivels, where there are the only grease nipples. A rack and pinion steering mechanism, of Lea-Francis design, has been adopted and the layout follows the usual practice of using the rack as the centre portion of what is in effect a three-piece track rod.

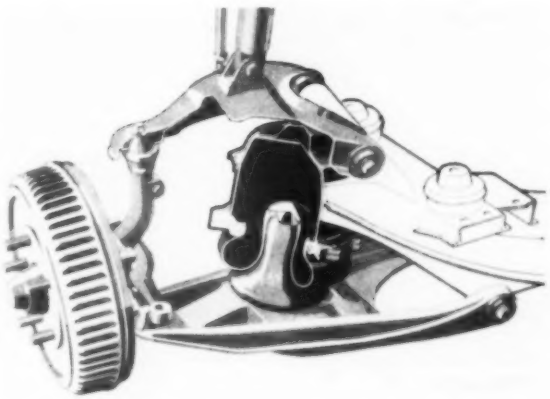
On the Lotus Elite Series II, a modified independent rear suspension is employed. As before, it is based on a strut incorporating a coil spring and telescopic damper, but, instead of the single trailing arm of the earlier version, there is now a narrow reversed lateral wishbone pivoted, at its apex, on an axis through the inboard universal joint centre. Thus, a part of the lateral loading is now taken by the wishbone instead of being carried entirely by the drive shaft, which is of the double-articulated fixed-length type, and longitudinal loading is also taken by both, since together they form a triangulated link arrangement. The suspension has been designed to produce a certain amount of camber change with increase in load, to maintain good handling characteristics under all conditions.

The new Lotus formula junior racing car, exhibited at Earls Court, has an independent rear suspension system consisting of two long trailing arms at each side, inclined laterally at a small angle to the longitudinal axis of the vehicle, an articulated fixed-length drive shaft and a lower transverse arm, which carries the lower end of the combined coil spring and damper unit. In effect, this is a double wishbone layout, with oblique pivot axes: the upper trailing arm and the drive shaft form one wishbone, and the lower trailing arm and the transverse arm comprise the other. In contrast to the Elite front suspension, in which the lower wishbone is replaced by a transverse radius arm and an anti-roll bar, that of the formula junior car has two unequal length wishbones and a separate anti-roll bar. On both vehicles, however, the springing is effected by means of combined coil spring and damper units.

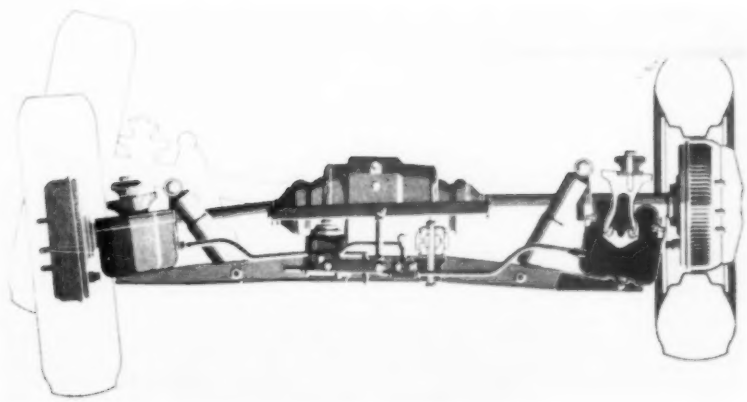
In the front suspension of the Peugeot 404, another newcomer to Earls Court, a break has been made with earlier Peugeot practice. The layout is basically similar to the Macpherson strut type already mentioned. However, unlike the Ford suspension, that of the Peugeot does not have an anti-roll bar, the transverse lower link being braced by a diagonal tie. The telescopic dampers, around which the

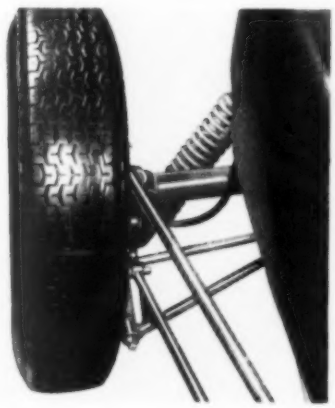


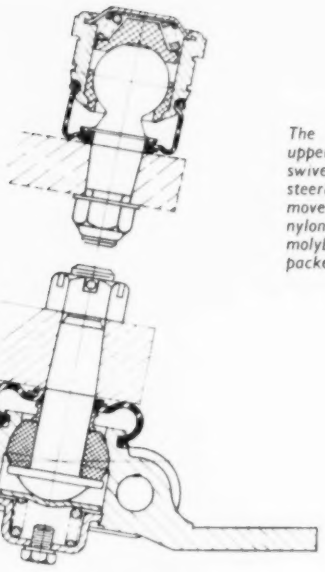
The illustration on the left shows the rear suspension of the Lotus Junior, and the front suspension can just be seen in the background. There are two trailing links, one of which is almost concealed behind the spring and shock absorber assembly, but this second link can be seen clearly in the illustration in the bottom right-hand corner



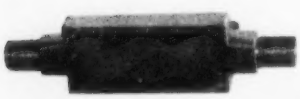
Above: Details of the front suspension of the Borgward 2·3 litre car. The air springs, which are of the rolling diaphragm type and are similar to the Firestone Airide units, simply replace the coil springs in the double transverse wishbone independent front suspension. Below, left: Similar springs are used in the swing axle type rear suspension assembly







The Thompson joints for the upper and lower ends of the swivel pin accommodate both steering and suspension arm movements. They have moulded nylon bearings impregnated with molybdenum disulphide and are packed with grease on assembly



Mintex unlubricated bearing assembly sectioned to show the plastics bearing material between the convoluted pin and the steel outer shell

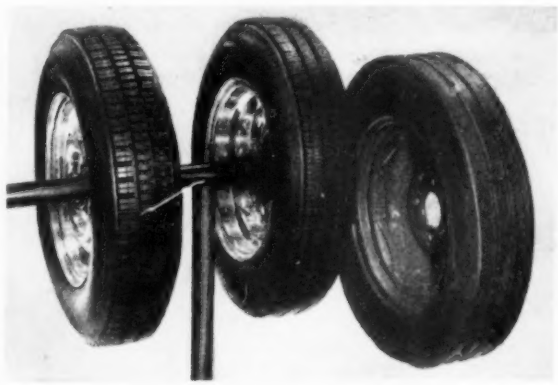
whole front suspension is virtually built, are of Peugeot design and manufacture. A rack and pinion type steering gear is fitted to this car, and gives good handling qualities.

The torque tube drive used by Peugeot for many years is retained for the rear suspension of the 404 car. Unsprung weight has been reduced, however, by employing aluminium for the centre casing and for each of the axle trumpet cases. The use of coil springs also helps to keep down the unsprung mass. A panhard rod affords transverse location of the rear axle, and the telescopic dampers—again of Peugeot design and manufacture—are mounted at an angle to the vertical, ahead of the springs.

Although torque tube drive has also been a feature of Buick cars for many years, it no longer appears on the latest models of this marque. The large Buick models now have an open drive and, although they retain a rigid axle and coil springs, the axle is now located by radius arms. Far more interesting, however, are the new Buick Special, a recently introduced compact model, and the Oldsmobile F-85, which is largely similar. These two new General Motors additions to the growing number of smaller American cars have an independent front suspension similar to that of the Chevrolet Corvair introduced last year. It consists of two wishbones, with ball joints at their outer ends, the pivot axes of which are inclined to the horizontal. The purpose of the inclination is to reduce front end dip on braking, by producing a vertical force component opposing the dynamic weight transfer. Coil springs are used: they are on seatings on the lower wishbones and are coaxial with the telescopic dampers, and the suspension system also includes an anti-roll bar connected to the lower wishbones.

In view of the fact that the Chevrolet Corvair has an independent rear suspension of the modified swing axle type, it is of considerable interest that the Buick Special and the Oldsmobile F-85, both later models, still feature rigid live axles. In the case of the Corvair, of course, the rear engine arrangement made an independent rear suspension unavoidable, but the retention of the rigid live axle on the two newer cars could not have been dictated solely by the fact that their engines are at the front, for this engine disposition has also been adopted for the new Pontiac Tempest, which does not have a rigid rear axle. The Tempest, which has virtually the same body shell as the Buick Special and the Oldsmobile F-85, was not, unfortunately, exhibited at Earls Court, but it is known to have an independent rear suspension of the swing axle type.

On these Buick and Oldsmobile cars, the rear axle is located by two pairs of arms. There are two long, rubber-mounted trailing links, one on each side, situated close to the wheels and attached to the underside of the axle tubes by rubber-bushed pins. These trailing links react the driving and braking forces and they also carry the seats for the coil springs. Side loads are taken by two shorter oblique links, also rubber mounted, which extend inwards from each side of the body structure to the top of the differential casing. The relatively high attachment points of the oblique links to the axle, together with the low attachment points of the trailing links, prevent axle wind up. Coil springs and telescopic dampers are employed; the dampers are mounted behind the springs and are inclined inward from the vertical.



Pirelli BS3 tyres, with winter and summer tread bands, and a bare case

Another new American compact model, the Dodge Lancer, has the same suspension systems as the other and earlier compact car produced by the Chrysler Corporation, namely the Plymouth Valiant. The independent front suspension consists of two transverse links, with ball joints at their outer ends and a longitudinally mounted torsion bar spring on each side of the car. A pressed steel wishbone comprises the upper link, while the lower one is a simpler pressing and is located longitudinally by a drag link. The rear anchorages of the torsion bars are integral with the transverse member that supports the rear of the engine: at the front, the torsion bars are anchored to the lower links, which also embody attachment points for the lower ends of the telescopic dampers. For the rear suspension, a conventional layout is employed. The semi-elliptic leaf springs are 55 in long and 2½ in wide; there are four leaves in the case of the saloon and five in the estate car version.

From the suspension point of view, one of the most interesting exhibits was the Borgward 2·3 litre six-cylinder car with a Bosch air springing system. It is the first European quantity produced car to be offered with a constant-rate suspension, and its introduction is of particular significance in view of the marked eclipse of air suspensions in the U.S.A, after the upsurge of popularity there a few

years ago. The air suspension system of the Borgward includes four rolling-diaphragm air springs, which are similar to the Firestone Airide units and which replace coil springs in the double wishbone independent front suspenson and in the swing axle independent rear suspension.

At the front, there are two Bosch levelling valves, one on each side of the engine compartment; they are actuated by long rods attached to the upper wishbones of the suspension assemblies. The air springs are mounted between the lower wishbones and the front cross member. At the rear there is only one levelling valve; it is carried on the rear cross member and is operated by a lever and tie rod connection to a long bar attached to the inner ends of the swinging axle tubes. Thus, the levelling valve responds to vertical movement of the body relative to the wheels rather than to body roll when the vehicle is being driven round a corner.

Component development

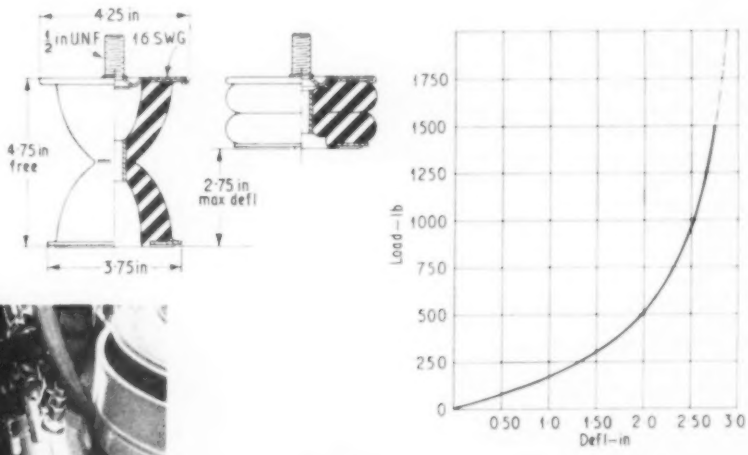
Apart from the major suspension developments outlined, there has been a number of improvements to existing designs, as well as interesting progress in respect of components. The former are exemplified by the changes made by the Rootes Group to their Sunbeam Alpine, Humber Hawk and Super Snipe cars. In the case of the Alpine, six greasing points have been eliminated by using nylon bushes for the track rod joints and the upper swivel bearings, and the width of the rear leaf springs has been increased from $1\frac{1}{4}$ in to $2\frac{1}{4}$ in to improve lateral stability. On the Humber Hawk and Super Snipe, metallic swivel bushes have been replaced by Glacier DU components; in the interest of improved handling at high speeds, the rate of the coil type front springs has been increased, and the leaf width of the two rear springs has also been increased, from $2\frac{1}{2}$ to 3 in.

The changes involving the elimination of grease points are indicative of the general trend towards the evolution of chassis that will require no lubrication in service. In fact, the latest Cadillac series Sixty and Sixty-Two cars, which were exhibited at Earls Court, are already advertised as having attained this ideal. Yet another interesting indication of the trend is provided by the new Thompson self-lubricating suspension and steering joints developed by the Automotive Products Co. Ltd. The suspension upper ball joint consists of a ball-pin carried in two moulded nylon half-bearings, which are impregnated with molybdenum disulphide; the joint is packed with grease on assembly and sealed.

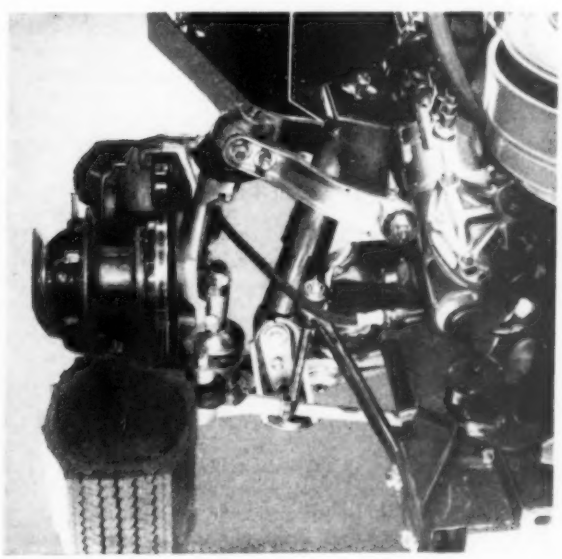
Comprising the lower suspension joint is a mushroom-type pin and a one-piece nylon bearing, again impregnated with molybdenum disulphide. This joint, too, is packed with grease on assembly but in this case, because it is more heavily loaded than the upper joint, there is provision for refilling with grease should this ever prove necessary in service. Both joints are protected, by a positively sealed rubber boot, against dirt and the entry of moisture and grit. The self-lubricating ball joint for steering linkages is similar in principle to the suspension upper ball joint and, like this, it incorporates a split impregnated nylon bearing. It should perhaps be emphasized that the principal object in developing this type of joint for steering linkages has been the elimination of lubrication and not the reduction of friction.

An interesting self-locating and self-sealing unlubricated bearing for high-load, low-speed applications has been developed by the Mintex division of British Belting and Asbestos Ltd. The example shown consists of a steel pin, of convoluted form, and a pair of metal half-shells; the

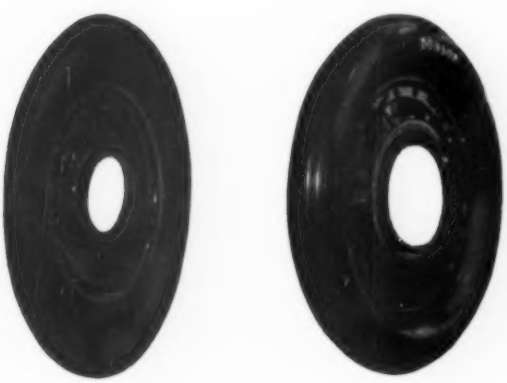
Metalastik Springaid auxiliary spring which, in some instances, relieves the main spring of as much as half of the bump load. The load-deflection curve is shown on the right

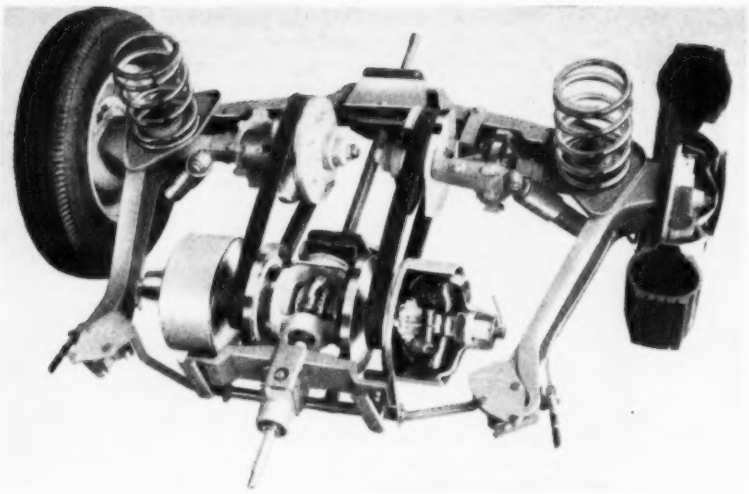


Below: Offside front suspension assembly of the Rover 3 Litre, with the Hydrosteer power assistance unit mounted on top of the frame side member immediately inboard of it



Below, right: Two Dunlop Standby wheels, one shown inflated and the other deflated





The DAF rear suspension system has been exhibited before, but this year, for the first time, the transmission components were shown sectioned to reveal details

space between the shell and the pin is occupied by non-metallic materials. In contact with the pin there is a thin layer of p.t.f.e. fibre, about 0·015 in thick, which forms the bearing surface; outside this p.t.f.e. layer is a suitable backing material, such as asbestos reinforced phenolic resin, which is bonded, during moulding, to the two half-shells. The dimensions of the components are such that, after manufacture, there is appreciable interference between the pin and the bearing material, and this is increased somewhat if the bearing is an interference fit in its housing. Because of its self-sealing and dirt excluding properties this bearing is thought to be particularly attractive for suspension systems operating in adverse conditions, and it is also considered that higher loads might be carried than by rubber-bushed pins of similar size.

A new auxiliary rubber spring, which might assist conventional suspensions to cope with a wide range of load, has been developed by Metalastik Ltd. It consists of a single rubber moulding in the shape of two hollow cones joined at their apices; a tubular guide is moulded into the rubber at the waist. The free height of the small unit, which is suitable for cars and light commercial vehicles, is 4·75 in between the end flanges, and the height at maximum deflection is only 2 in. Over its working range, the spring provides a progressive action: its stiffness increases from a very low initial value, so that, when employed as a buffer, it can come into action without shock.

Problems arising from the wide range of loads to which vehicles are subjected has prompted the development of adjustable dampers by Armstrong Patents Co. Ltd. Two types are available, lever and telescopic: the first has the designations DAS 9 and 10, and the second model is the AT 9. In both cases, the degree of the damping is varied by adjusting the rate of bleed through an orifice, by means of a needle valve. Work diagrams for a typical damper show a ratio of more than 2:1 between the maximum blow-off speeds at the firm and soft settings of the bleed valve, and a ratio of about 10:1 between the maximum bleed speeds at the two settings. On the dampers exhibited, the bleed valve adjustment is effected by rotating the valve cover; in practice, this would necessitate getting underneath the vehicle, but it is understood that a remote control system is under development.

Power-assisted steering

Almost the only major steering development of note this year is the adoption of Hydrosteer power-assisted steering as an optional extra on the Rover 3 Litre car. This unit, which was described in the May 1960 issue of *Automobile Engineer*, is of the integral type: the hydraulic servo is contained within the steering box and there are no external valves or cylinders. The basic mechanism is of the cam and peg type. Surrounding the cam is a piston working in a steel tube fitted into the aluminium alloy body of the steering box. Thrust from this piston is transmitted through a spherical portion of the peg housing, which registers in a hole in the piston skirt, to the rocker shaft.

Control of the oil flow to the appropriate side of the piston is effected by a spool valve of unorthodox design mounted at the upper end of the cam. Turning the steering wheel against resistance from the road wheels causes an axial reaction between the cam and peg, the cam tending to move axially up or down according to the direction of rotation of the wheel. This axial movement is used to operate the spool valve against the centralizing thrust of a pair of disc type springs, which locate the spool in its neutral position when no steering effort is applied. Noteworthy features of the valve are the use of annular abutment faces, on the spool ends, and also of sealing rings in the valve chamber walls. Consequently, there is no reliance on close diametral fits, and so there is little possibility of jamming due to foreign matter in the oil.

Oil is supplied to the unit by a Hobourn-Eaton roller-vane pump and is directed to one side or the other of the piston by the spool valve, the resulting thrust acting on the rocker shaft to assist the driver's effort. The amount of hydraulic assistance is dependent on the movement of the spool, which is proportional to the effort applied by the driver to the steering wheel. To obtain the maximum advantage from the power assistance, the cam form has been designed to provide a progressive variation in ratio from a moderate figure in the straight-ahead position to a numerically lower ratio towards each lock. Thus the number of steering wheel turns between locks has been reduced on the Rover 3 Litre from the 4½ of the manually steered version to 2½, without making the gearing too direct, round the straight-ahead position, for safety at high speeds.

Tyres

Noteworthy new developments in the field of car tyres were represented by four exhibits: these were a tyre of the type used on Donald Campbell's C.N.7 Bluebird car during the recent attempt on the world land speed record, the Pirelli BS-3 tyre with replaceable tread, the Dunlop Elite tyre, in which high-hysteresis rubber is used, and the Dunlop Standby wheel. The C.N.7 tyre is of rather esoteric

interest, being well outside the range of normal car tyres both in size and designed performance. It has a nominal size of 7.0-41 in, and the tread is only 0·02 in thick, compared with the figure of about $\frac{3}{8}$ in on normal car tyres; the thickness has to be kept to a minimum, of course, on account of the high centrifugal forces generated, and yet it has to be adequate to protect the casing during at least one run at really high speed.

Because of the high inflation pressures used, the deflection of the tyre walls is small. Consequently, in the selection of textile material for the casing, fatigue considerations can be subordinated to those of tensile strength and low stretch. For this reason Fortisan rayon fabric was chosen. The equally important requirement of low heat generation in the tyre necessitated the use of a low-hysteresis rubber compound for the tread and casing. Tyre fling under centrifugal loading is minimized by the use of an unusually squat section.

The Pirelli BS-3 tyres are a logical means of increasing tyre life which, in normal conditions, is limited by tread wear. Therefore, the casing and the tread are separate components, the latter being in the form of rubber bands reinforced by metallic cords laid longitudinally. In car sizes, the BS-3 tyre has three tread bands, and these can readily be replaced when worn, or interchanged laterally to reduce uneven wear across the face of the tread. Another feature is that special winter tread bands can be fitted in place of the standard bands; in addition, when these winter bands are to be used on icy roads, special spikes tipped with tungsten carbide can be inserted between the edges of the central band and the inner edges of the outboard bands. Production of the BS-3 tyres is about to begin in this country, but initially they will be available only in the 5.90-14 sizes, which is that employed on, for example, the B.M.C. 1½ litre Farina styled cars and on the latest Vauxhall Velox and Cresta models.

Much attention has recently been given to the possibility of improving the adhesion of tyres by the use of high-hysteresis rubber compounds. It has been known for some time that rubbers with high energy absorption characteristics develop higher coefficients of friction than do normal rubbers, and a suitable high-hysteresis synthetic rubber compound has now been developed for use in tyre treads. A rubber of this type is used for the tread of the Dunlop Elite tyre. The claims made for the Elite tyre, in respect of improved adhesion, are considerable: they include a 45 per cent shorter wet-road braking distance than that of standard tyres. These improvements are certainly significant, but a price has to be paid for them in the form of higher running temperatures, which necessitate the use of high-tenacity nylon casing material, and rolling resistance is increased. It is stated that, in the case of a normal 2 litre saloon, the additional rolling resistance increases fuel consumption by only 2 per cent but, because of the amount of heat generated, the tyre is not suitable for sustained high-speed operation. A secondary feature of the Elite is that a new tread pattern with a reduced number of ribs, made possible by the improved adhesion of the tyre, has been adopted in the interest of longer tread life. There is also a large number of sipes of corrugated form, which promote a wiping action on wet surfaces.

The amount of space occupied in a car by the normal spare wheel and tyre has prompted the development of special and less bulky units. One such recent development, introduced in the U.S.A, consisted of a narrow solid tyre, which could be bolted on without removing the damaged tyre. The utility of a solid spare of this type is, of course, severely limited; this criticism also applies, though to a considerably lesser extent, to the Standby Wheel exhibited by the Dunlop Rim and Wheel Co. Ltd. This Standby Wheel comprises a special pneumatic tyre, with a 2-ply casing, mounted integrally on a pressed steel wheel having a narrow rim. When the tyre is deflated, the unit is only $\frac{3}{4}$ in thick, in the size that replaces a 5.20-13 in standard tyre, and is still only 1¼ in thick in the form used to replace an 8.20-15 in tyre.

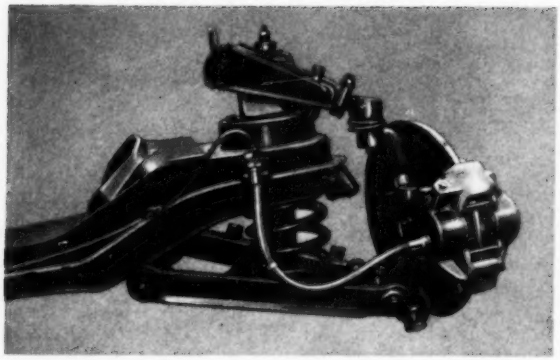
Inflation is normally by means of a small carbon dioxide cylinder, about 10 in long, and the designed operating pressure is about 50 lb/in^2. If the carbon dioxide is used for inflation, it is necessary to top up at 8 hour intervals. The tyre can, of course, also be inflated by conventional methods. Used in place of a damaged tyre, the Standby Wheel allows the vehicle to be driven at reasonable speed, but it is only intended for use in emergencies; because of the bonded-on construction, the tyre cannot be changed.

BRAKES

Disc Brakes Increasingly Employed; Mechanical Application of Vacuum Servo Assistance; Improved Trailer Braking for Caravans

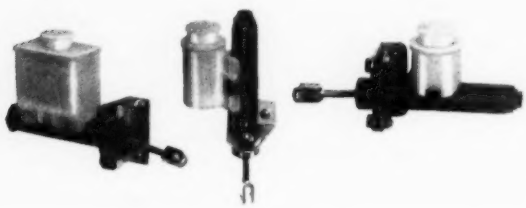
In an exhibition containing relatively few innovations in chassis design, many new developments in braking equipment were hardly to be expected. In fact, the equipment on the majority of cars displayed at Earls Court differed little, if at all, from that of a year ago. It was not surprising to find that the most noticeable progress was in the extended use of disc brakes. As regards British cars, disc brakes are now fitted as standard on all four wheels of a number of the more powerful touring and sports models, whereas disc brakes on the front wheels are either standard or optional on numerous other cars of varying size and performance. There seems to be no doubt that the swing from drum brakes, particularly for front wheels, will continue, and that it would be accelerated if the cost disadvantage of the disc type could be reduced.

In practically all cases, the proprietary brakes of both drum and disc type are substantially similar to those displayed at last year's exhibition, though on some makes of car the swept area has been increased by employing drums of larger diameter or shoes of greater width. Hydraulic application continues to be universal, but there is a tendency towards the wider adoption of power assistance, by vacuum servo, on cars of medium size, to reduce driver fatigue caused by the high frequency of brake applications under modern traffic conditions. In this connection, the introduction of vacuum servo units that are applied directly by the brake pedal, instead of through the medium of the hydraulic system, is a promising development, offering both practical and economic advantages. With this arrangement the servo unit is mounted with the master cylinder on the bulkhead, close to the brake pedal and the source of vacuum, independently of the hydraulic equipment. The installation cost should be lower than that of the conventional remote mounting, with its hydraulic connections, and the servo unit is also more easily accessible for servicing attention. In certain cases, however, the change of position may necessitate some rearrangement of other items normally accommodated on the bulkhead.



Above: Among the exhibits on the Lockheed stand was this Sunbeam Rapier front suspension assembly equipped with the disc brake unit

One of the recent developments is the employment of translucent plastics reservoirs on the Lockheed brake master cylinders. The principal advantage of this arrangement is, of course, that the fluid level can be readily checked visually without removing the filler cap



Inboard mounting of the brakes, though it offers the advantages of reduced unsprung weight and less restriction of drum diameter than applies in the case of a wheel mounting, continues to have few adherents. It is a feature of the Lancia Flaminia and the Citroën ID and DS front-wheel-drive cars, which have Dunlop disc brake equipment, and of the Lotus Elite, on which the disc brakes are of Girling manufacture. Inboard drum brakes are employed on the front-wheel-drive Auto Union DKW Junior. The Citroën brakes are protected from water and dirt by partial enclosure in the engine and transmission housing, but are cooled by air admitted through inlets at the front of the car.

In few instances are the inner surfaces of brake discs provided with protective shields. Included among the exceptions is the Ford-Girling equipment optionally available on the Ford Consul, Zephyr and Zodiac models; such shields are also featured on the 1961 version of the Sunbeam Alpine. The absence of shields is inevitably conducive of unequal wear of the friction pads on the two sides of the disc, though the latest pad materials give a working life equal to that of shoe linings.

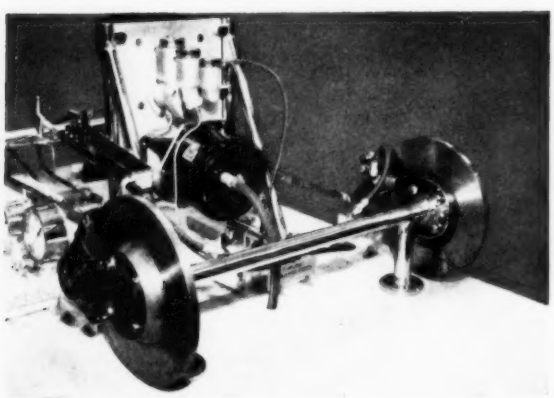
For owners of Ford Mark II Consul, Zephyr and Zodiac cars with drum brakes, the optional Ford-Girling front wheel disc brake equipment is available in the form of a conversion kit. By intelligent design, the task of conversion has been made a comparatively simple undertaking. After the wheel is removed, the drum brake, complete with its backplate, and the hub are taken off and discarded. The brake disc, 9·75 in diameter × 0·5 in thick, is attached to the replacement hub, and the caliper unit is mounted on a special bracket, secured to the hub by two bolts and a set-screw.

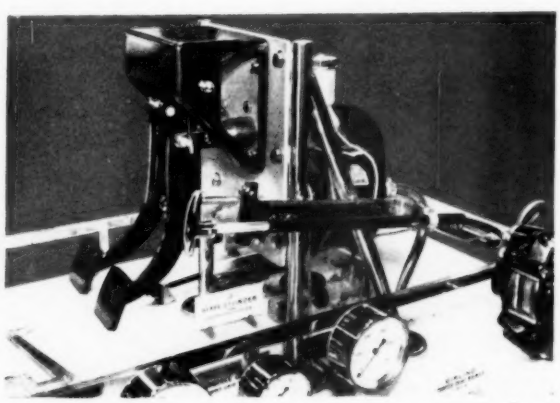
The bracket carries a dirt shield, which covers about three-quarters of the disc area, the remainder being protected by the caliper. Included in the kit is a Girling type 689 vacuum servo, of 7 in^3 capacity, and a vacuum reservoir, which are installed under the bonnet. Because the servo boosts the application pressure to the rear brakes as well as the front, the original braking effort distribution between front and rear is maintained by fitting hydraulic cylinders of 0·7 in bore to the rear brakes, in place of the 0·875 in diameter cylinders previously used.

A demonstration installation on the stand of Girling Ltd. illustrated the advantages of the direct application of vacuum servo assistance to the brake pedal. The new Girling suspended vacuum servo unit was shown mounted on the front of a bulkhead, below a tandem master cylinder and a clutch hydraulic actuating cylinder. This equipment incorporated the safety feature of completely independent operation of the front and rear wheel brakes; each system had a separate fluid reservoir. There are no moving seals in the bore of the tandem cylinder; consequently there is no risk of scoring. Since the pressures in the two chambers are nearly balanced, the seal dividing them should have a long life. Another feature is that the valves operate simultaneously instead of in sequence, giving a single cut-off effect and minimizing ineffective pedal travel. Any air that may be entrapped in the cylinder escapes, because the hydraulic circuit is self-bleeding.

As regards the actual installation, the piston of the master cylinder is connected directly—by a rod passing through a hole in the bulkhead—to a point near the upper end of the pendant pedal. Similarly, a hollow tie connects the servo piston to the lower end of the power lever which, also

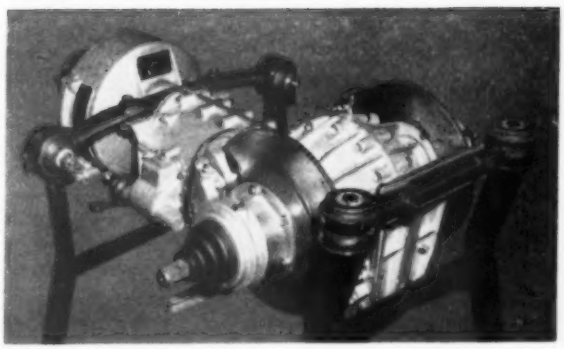
Below are two views of the demonstration installation of the new Girling suspended vacuum servo unit and tandem master cylinder; one of the noteworthy features is that the power assistance is applied directly to the brake pedal, by a link that can be seen in the right-hand illustration

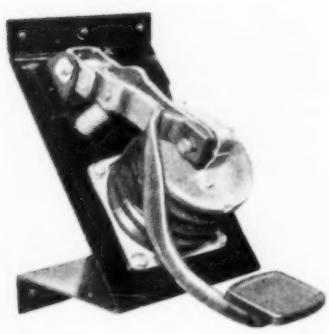


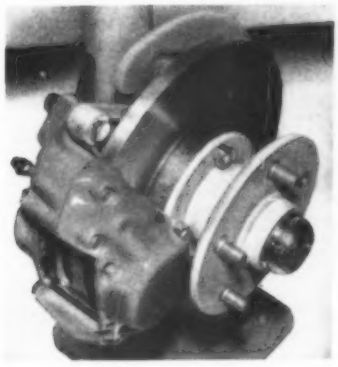


pivoted at its upper end, is mounted beside the pedal. An extension of the upper end of the power lever is bent over and carries a substantial cross pin which bears against the pedal to transmit the power assistance to it. Pivoted on one side of the power lever is a trigger, one end of which is connected by a spring-loaded rod, passing through the hollow tie, to the air and vacuum valves; the other end of the trigger is actuated by a bent-over extension of the upper end of the brake pedal.

Initial movement of the pedal actuates not only the master cylinder unit but also the trigger mechanism. This latter opens the air valve and closes the vacuum valve, both of which are housed in the centre of the servo piston. The air passes, through a filter and the valve, to the rear end of the cylinder, and so pushes the piston, and therefore the







Above: Dunlop disc brakes on the clutch, gearbox and final drive assembly at the rear of the Lancia Flaminia; they are actuated by either the foot or the hand control

Extreme left: The Dunlop vacuum-operated rubber bellows type booster unit, by means of which servo assistance is applied directly to the driver's brake control pedal

Left: Ford-Girling disc brake unit fitted as an optional extra or obtainable as a conversion on the Consul, Zephyr and Zodiac

power lever, forward. The cross pin on the power lever applies the assistance, with a leverage of about 2 : 1, to the pedal, and this assistance is proportional to the pedal movement.

Upon release of the pedal, the return spring moves it and the power lever to the inoperative position, closing the air valve and opening the vacuum valve; at the same time, the piston is moved back to its suspended position by a return spring. In the event of vacuum failure, brake operation by pedal pressure alone is unaffected, and the servo cylinder capacity is sufficient for several applications. If desired, the servo can be connected to a reservoir instead of directly to the inlet manifold.

The same purposes are achieved by the new Dunlop booster, which incorporates a Kelsey-Hayes vacuum-operated rubber bellows unit. The example exhibited was arranged for mounting on the back of the bulkhead, in front of the brake pedal. A push rod passing through the bulkhead connects the pedal to the master cylinder on the other side. The bellows unit presents no frictional or leakage problems, and is simple in design and operation; in addition, it is easily installed and maintained, and its initial cost is relatively low.

As shown in the accompanying illustration, the power lever and pendant pedal are side by side. The upper end of the power lever is bent double to form a U, the arms of which are bridged by its pivot pin and a tubular distance piece : a bracket, attached to the dash structure, carries the ends of the pin. Immediately below this pin, and parallel to it, is the pivot pin for the pendant pedal, the upper end of which is also carried between the arms of the U. The lower end of the power lever is pinned to the centre of the end-cover of the bellows. An extension of the pin by means of which this connection is effected projects towards the brake pedal, which at this point is forked, one arm carrying the foot pad and the other, a much shorter one, having a hole into which the pin projects. There is a rubber sleeve around the pin and a clearance between it and the hole, so that the pedal can be moved a small distance independently of the power arm, for actuation of the valve control button.

This button, which is immediately below the pivot pin, projects through the centre of the end-cover of the bellows, and it is actuated by a lug extending laterally from the pedal, at a point below the clearance hole. The connecting pin is eccentrically mounted, and has a spring locking device, so adjustment can be made of the clearance between the valve button and the lug that actuates it, and therefore of the amount of pedal travel needed to depress the button. An eccentric adjustment device is also provided for the pin attaching the master cylinder push rod to the pedal; this pin is a short distance down the pedal from its pivot on the power lever. The push rod passes through a coil return spring.

In the bellows end cover is a pipe connection to the vacuum reservoir. Also in the end cover, but within the bellows, are a vacuum valve and an air admission valve, both of which are spring loaded. The air valve is actuated by the control button just mentioned, and it communicates, through a central tube, with an inlet mounted on the base-plate and protruding through the bulkhead. In the brakes off position, the bellows, which is provided with internal support, is fully extended by a return spring and is filled with air; the air valve is open and the vacuum valve closed. Immediately the pedal is depressed to apply the brakes, the trigger makes contact with the button and depresses it, thereby closing the air valve. Continued movement opens the vacuum valve, and this causes the bellows to contract and so applies additional pressure to the pedal through the rubber-covered pin, which has cushioning effect by virtue

of the rubber sleeve. Movement of the bellows tends to take the air valve button away from the trigger, with the result that air exhaustion from the bellows ceases until greater pressure is applied to the pedal, by the driver of the vehicle.

If the pedal is held stationary, both valves immediately close and the booster remains poised until the pedal is further depressed or released. When the brakes are applied heavily and the booster is giving maximum assistance, extra pedal effort increases the thrust applied to the master cylinder : full booster assistance is, of course, maintained in this event. Upon release of the brake, the trigger moves away from the air valve button, the vacuum valve closes and the air valve reopens, so air enters the bellows and causes it to expand. If the brakes are partially released and held at any point, the assistance is maintained at the appropriate level until the driver's effort on the pedal is completely removed.

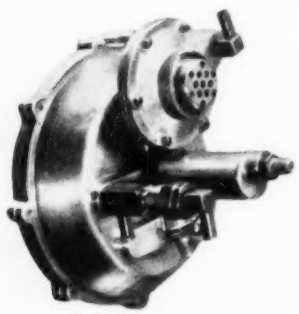
For providing vacuum power-assistance to the hydraulic braking of medium-sized cars, the new Lockheed $5\frac{1}{2}$ in diameter servo unit has been introduced. It is a smaller and lighter diaphragm version of the $6\frac{7}{8}$ in, piston type unit, and operates on the same principle. Like its predecessor, it comprises a vacuum power cylinder, diaphragm control valve and air filter, combined in one compact unit with a hydraulic slave cylinder. It is equipped for connection to the hydraulic master cylinder and brake pipe lines, and to the engine inlet manifold or vacuum reservoir; the system incorporates an air cleaner. There are no external levers, rods or links to become clogged with rust or dirt, or to require adjustment, all the working parts being enclosed in the unit; it follows that optimum reliability can be expected and maintenance requirements should be at a minimum.

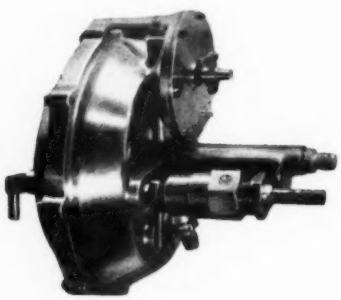
The servo unit, which weighs about $7\frac{1}{4}$ lb and has a vacuum cylinder capacity of about 6·5 in^3, is available with a choice of four sizes of slave cylinders—$\frac{5}{8}$ in, $\frac{11}{16}$ in, $\frac{3}{4}$ in, and $\frac{7}{8}$ in bore—and so is suitable for a wide variety of sizes of car. Since it is not subject to reaction forces, it can be installed on light mountings in any convenient position on the chassis, and be inserted in any suitable hydraulic system without alteration to the master cylinder or pedal ratio. The unit is offered as original equipment for new vehicles, or for the conversion of existing braking systems to power control.

A long overdue improvement of caravan trailer braking is provided by the adaptation of the Clayton Dewandre Mot-A-Vac suspended vacuum-hydraulic servo to this purpose. The advantages of this new power-assisted braking system should be assessed in comparison with the conventional over-run brake, which begins to operate only after the towing car starts to decelerate, with the consequent liability of judder and jack-knifing. This adaptation, on the other hand, permits the installation of vacuum-boosted hydraulic trailer brakes, while avoiding the problems of making readily detachable hydraulic connections between the vehicles and of ensuring that both are braked simultaneously in proportion to the pressure that is applied to the pedal.

The towing car is fitted with a standard Mot-A-Vac unit, and a slightly modified version, without the integral control valve, is installed as a slave unit on the trailer. These two units are connected by two pipe lines fitted with self-sealing couplings. One is a constant-vacuum line connecting the constant-vacuum chamber on the car unit to that of the trailer slave unit through a breakaway valve. The other is a control vacuum line connecting the integral control valve of the car unit to the power chamber of the slave unit on the caravan.

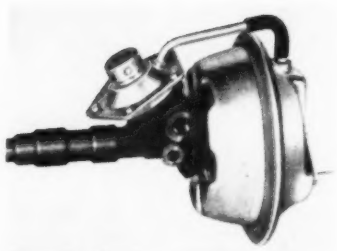
On both vehicles, the hydraulic output cylinder is connected to the wheel brake cylinders, and that on the trailer has a separate fluid reservoir. In the event of a breakaway of the caravan, the self-sealing couplings protect the Mot-A-Vac on the car, and the breakaway valve on the trailer slave unit causes the trailer brakes to be applied automatically. A vacuum release cock on the slave servo permits the brakes to be released in order that the towed vehicle can be moved independently when it is disconnected, or accidentally breaks away, from the car that is towing it.





This is the slave unit of the Clayton Dewandre Mot-A-Vac system for caravans. In conjunction with the master cylinder, it operates to apply the brakes of the trailer and towed vehicle simultaneously

Above: The master unit of the Clayton Dewandre Mot-A-Vac suspended vacuum-hydraulic servo system for fitting to cars that are used for towing caravans; it actuates a slave unit mounted on the caravan



The Lockheed $5\frac{1}{2}$ in diameter servo unit for medium-size vehicles with hydraulic brakes. It is suitable either for initial equipment or for the conversion of the standard braking systems of existing vehicles

Electrical Equipment and Heaters

The Latest Features Include A.C. Generators, Twin-Pair Headlighting and Horizontal Scale Speedometers

SIGNIFICANT new features this year are a.c. generators, with built-in rectifiers, twin-pair headlighting and horizontal scale speedometers. On the score of cost, and also because the conventional dynamo output is normally adequate for cars, the a.c. generator will for some time—possibly several years—be limited in its application to vehicles with battery loads in excess of that of the normal private car. The introduction of the twin-pair headlamp system marks a further stage in the provision of better road illumination, from the viewpoints of drivers and of oncoming traffic, whereby night driving is made safer for all concerned. As admirably demonstrated by the exhibits, the new speedometers not only harmonize with the latest horizontal styling, but can also effect an appreciable reduction of the instrumentation area on the facia.

Although the sealed beam, all-glass headlamp unit introduced last year is not yet universally adopted, appreciable progress has been made in this direction. So far as accessories in general are concerned, there have been no outstanding new developments. A highlight, in connection with ignition, is the Champion Plug-Scope which, with its cathode ray traces of sparking plug voltages, might well be regarded as the cardiograph of the motor car. It certainly provides visual evidence of the ailments of the petrol engine ignition system, the proper interpretation of which can indicate the requisite remedial action.

The fact that nearly half-a-million cars in Great Britain are licensed for radio reception is proof of the popularity of automobile radio sets. Since the power transistor replaced the conventional output valve on 12 volt car radio receivers, and so rendered the high-voltage power pack redundant, the practice in general has been to use low-voltage valves for all stages except the output, for which the power transistor is employed. For operation on 6 volt battery systems, however, all-valve receivers are still necessary. Car radio receivers are of two main types, the compact manually tuned units and the de luxe push-button models available with a choice of standard or high-power amplifiers. The introduction of the portable radio for cars, as exemplified by the Transmobil 2 model of Lee Products (Great Britain) Ltd, may lead to full transistorization on the 12 volt unit, in order to reduce the current consumption still further, particularly for operation as a portable receiver with its own batteries. Another new and interesting automobile development is the Philips Auto-Mignon record player.

Lucas a.c. generator system

This new 12 volt a.c. generator equipment has been introduced to meet the requirements of cars and commercial vehicles on which, owing to exceptional battery loading or service operating conditions, there is difficulty in keeping the battery charged by means of a conventional dynamo. In this category can be included police cars and ambulances with two-way radio installations, and also tradesmen's vehicles operating short-distance delivery services, necessitating frequent engine starting. There is little doubt that this system is, nevertheless, the forerunner of the car generator system of the future, and it certainly will be widely employed even earlier on other classes of vehicle.

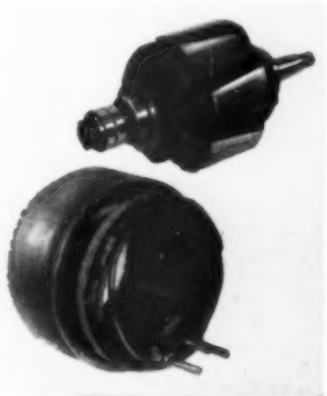
The main advantages of the a.c. generator are its high output and the fact that, owing to the absence of any commutator, it can be run at a higher speed than can a dynamo. These benefits combine to produce a system capable of giving a substantial output, even at engine idling speed, and also maximum output at relatively low road speeds. Other important advantages are long life, with a minimum of maintenance, and simplified output control.

A steady maximum output of 50 amperes at 13·5 volts is given by the Lucas unit at a generator speed of 3,000 r.p.m. which, with a drive ratio of 2:1, corresponds to a road speed in the region of 20 m.p.h. in top gear. At engine idling speed, with the drive ratio mentioned, the output would be of the order of 10 amperes.

The equipment comprises three main units. The first is a 2AC, 8-pole, 6 in diameter alternator, with six silicon rectifiers, connected to form a 3-phase bridge circuit, incorporated in the slip ring end bracket. This alternator is used in conjunction with a 2TR control box, in which a vibratory contact relay is employed to open and close the base circuit of a transistor included in the control box, whereby the alternator field current is controlled to regulate the alternator output. The third unit is a 6RA isolating relay, serving as a switching device to isolate the alternator field and regulator windings when the ignition is switched off. Operation of this output control was explained in the November 1960 issue of *Automobile Engineer*.

Lighting

The latest Humber Super Snipe has the distinction of being the first British production car to adopt the twin-pair headlamp layout. It is fitted with the Lucas four-headlamp system comprising two pairs of 5¼ in diameter metal-backed light units, each with an individually focused soldered-in bulb. One lamp of each pair has a single 37½ watt filament unit and the other a 50/37½ watt double-filament unit. The main driving light is provided by the four 37½ watt filaments, two for the foreground and the other pair for longer



Components of the Lucas alternator for cars and commercial vehicles. A rectifier is incorporated in the unit but the control must be separately installed

Paired Lucas headlamp arrangement on the latest Humber Super Snipe

distances, while the two 50 watt filaments alone provide the meeting or dipped beams.

With this dual arrangement, the overall lighting is appreciably improved, affording greater penetration and more uniform light distribution from the main beams, and good forward illumination from the meeting beams with negligible dazzle effect to oncoming drivers. Each light unit is carried in a seating rim attached by a three-point mounting to the lamp body pressing. Two of the mounting points are adjustable spring-loaded assemblies, whilst the third takes the form of a hard rubber pivot. Setting in the horizontal and vertical planes is easily effected by the adjustment of two screws, and the accuracy of alignment can be checked on a mechanical aimer.

As expected, following the advance information obtained last year from the Lucas organization, considerable progress has been made in the manufacture and application of the sealed beam, all-glass light units. These units are now standard equipment on the Vauxhall 1961 Cresta and Velox cars and will, no doubt, be widely adopted on other makes of car before very long. Private car owners will be interested to learn that A.E.I. sealed beam light units, approved by Lucas, are available from Mazda car bulb stockists for replacement purposes, both for the Vauxhall 1961 cars and for conversions. They are interchangeable with many modern 7 in right-hand-drive headlamp units.

New lighting developments by Lucas included a headlamp conversion set, specially designed to replace the standard units on 1953 to 1959 Ford Popular cars to provide improved lighting. There is also the pleasingly styled model 564 rear lamp, on which one hole serves both for fixing and for the cable inlet. Finally, the model 3FB mounting bracket has been introduced for clamping Lucas auxiliary lamps to the over-riders of B.M.C. Farina styled cars.

Among the many attractively designed auxiliary lamp exhibits, the new Jupiter fog, driving and spot lamps, made by Butlers Ltd, were especially noteworthy for the fact that the distance from the mounting axis to the back of the lamp body is only $\frac{1}{4}$ in. This renders them particularly suitable for fitting to vehicles on which the frontal space for mounting is very restricted. Another new lamp of elegant appearance and styling is the Marchal Fantastic 651 fog lamp.

An interesting exhibit of the Wipac Group is the new Penetrac Continental pre-focus light unit, equipped with a Duplo-cadmium yellow 12 volt, 45/40 watt bulb and special lens providing vertical dipping with a sharp cut-off. This is a 7 in headlamp unit suitable as a replacement on practically any car manufactured since 1951; it fully meets Continental lighting requirements. The Lumax $3\frac{1}{4}$ in diameter reversing lamp is small, with a pleasing appearance and an excellent finish. It is fitted with a 21 watt bulb, which gives a wide-angle, diffused beam, and can be supplied complete with an illuminated switch.

The Butler Flexilight reading lamp, though somewhat unusual in appearance, is of sound design and is a most efficient and adaptable lamp for its purpose. It would be a very useful accessory for car navigators or business executives who need to read when travelling. Installed under the bonnet, it could also constitute an excellent inspection lamp. It consists of a mounting base and a 1 ft 10 in long stalk, armoured and chromium plated, to the extremity of which is secured a small shaded bulb holder with a switch. Though flexible, the stalk is sufficiently stiff to remain set after the light has been adjusted to the desired position. The light is quite adequate for reading and would not in any way hamper the driver's vision of the road.

Batteries

No notable innovations in battery design were revealed, with the exception of the Exide Auto-fil battery, which is available in the two most popular 12 volt sizes, namely, those with 43 and 57 ampere-hour capacities on a 20 hour rating. The functioning of the ingenious filling device on this battery was described in the November 1960 issue of *Automobile Engineer*. Now included in the Lucas S range, a feature of which is the streamlined cover, are the SF7 and SF9 models for replacement purposes on Ford cars. New models of the Dagenite Sheerline battery are also available for small British and Continental cars. A wide variety of replacement batteries manufactured by Park Bros. Ltd. includes a new Peak Power series, introduced to provide a reliable low-price battery for the motorist of limited income.

The Champion Plug-Scope is in effect a simplified version of the electronic test equipment used extensively for the ignition systems of aircraft engines

The range of battery chargers offered by each of the well-known manufacturers is sufficiently wide to cover the needs of the private car owner as well as those of both small and large service stations. The Siemens-Ediswan Mark II improved selenium rectifier charger is representative of the home charger class. It incorporates an ammeter and readily accessible fuses, and gives a 6 or 12 volt battery input of 3 amperes.

In an emergency arising as a result of a run-down battery, the Key-Leather battery booster cable is a useful device for starting an engine from the battery of another car. This device consists of a pair of 8 ft long, heavy-duty p.v.c. insulated cables, each of which has a robust spring grip connector at each end. For quick identification when coupling up the two car batteries, the connectors are provided with red and black p.v.c. insulated handles. Running the engine of the rescue car avoids any undue drain on the assisting battery when the two batteries are connected and starting is effected.

Ignition

There are no striking developments relating to ignition systems, either in regard to spark generators or sparking plugs. Into their comprehensive range of replacement com-

ponents, Park Bros Ltd. have introduced a new high-voltage, oil-filled ignition coil for which increased performance and better heat dissipation are claimed. A device which attracted considerable attention was the Champion Plug-Scope electronic sparking plug tester, with its miniature TV screen. This is certainly an extremely useful, as well as a compact and robust, instrument for garage staff. It is both quick and easy to operate and enables an operator with very little training rapidly to check the plugs under running conditions in the engine. In fact, it will do more than this: it will indicate also whether the ignition system voltage, for any reason, is inadequate for satisfactory operation.

Basically, the Plug-Scope is an electronic voltmeter, comprising a cathode ray oscilloscope and a transistorized power supply; the equipment is, in effect, a simplified version of the electronic ignition testers used extensively for aircraft engine maintenance. It can be applied to any petrol engine, having coil ignition, by four connectors: one is taken to each battery terminal, one to either the central terminal of the distributor or the h.t. terminal of the coil, whichever is the more accessible, and the fourth to any sparking plug or distributor plug lead terminal. This device can be operated from a 6 or a 12 volt battery system, without any change of connections, because an incorporated relay automatically inserts a series resistance to the higher voltage. In a matter of a few minutes, the operating conditions of all plugs and the overall efficiency of the ignition system can be determined from the vertical traces, on the oscilloscope screen, of the sparking voltage of the plugs and the maximum available voltage from the ignition system.

The heights of individual traces indicate the sparking voltages of the various plugs or, with a slight alteration to the connections, the open-circuit or maximum voltage of the ignition system. A horizontal red warning line is inscribed across the screen to indicate approximately two-thirds of the open-circuit voltage available from a satisfactory ignition system. Plug traces well below this line indicate normal sparking voltages at the plug electrodes, and traces above the line signify excessive plug voltages due to oversize electrode gaps; a very low trace would be indicative of a fouled plug. The incorrect ignition coil polarity for optimum ignition is immediately detected by the absence of the voltage traces when the engine is running, and this can be rectified by reversing the connections to the primary windings of the coil.

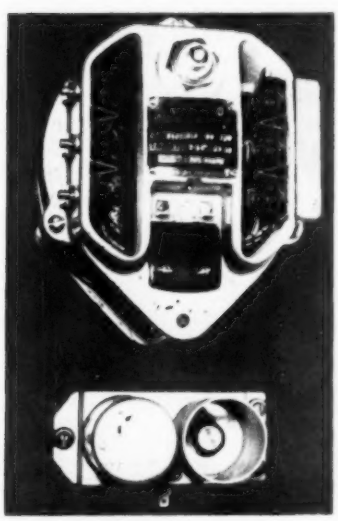
A very brief experience of using the Plug-Scope suffices to enable an operator quickly to decide, from the traces, the precise nature and location of almost any ignition defect. This is an instrument that could be invaluable to owners of fleets of petrol-engined vehicles. Its regular use would ensure not only that ignition systems were always maintained at maximum performance, but also that potential ignition failures were anticipated.

Speedometers and tachometers

One advantage of the horizontal scale speedometer is that it allows the instrument panel to be more easily harmonized with the interior styling of modern cars. It has the further benefit that it can provide a clearer indication of speed than does the conventional circular design. Moreover, it lends itself more readily to incorporation, with other instruments, in a common housing.

The new AC-Delco Safety-Liner speedometer is an attractively styled instrument operating on the magnetic drag principle, in which the speed cup constitutes a finely balanced cylindrical drum revolving on a horizontal axis. A coloured area on the drum is bounded by a helical line so that, as viewed through the horizontal slit in the dial, an effect of increasing band length from left to right across the dial is produced as the speed becomes greater. The advancing band is coloured green up to 30 m.p.h, at which point the whole band changes to orange; at 60 m.p.h. there is a second change, to red. In this way, visual warning is given of any contravention of the 30 m.p.h. speed limit, and the driver becomes conscious, too, of speeds in excess of 60 m.p.h. This new design of speedometer has been specially developed for the latest Vauxhall Cresta and Velox cars. It is housed within an instrument panel also incorporating the water temperature and fuel gauges which, together with the mileage recorder, produce a notably balanced arrangement.

A distinctive feature of the ribbon type horizontal scale speedometer manufactured by Smiths Motor Accessories



Above: Illustration showing one end of the Lucas alternator, with its rectifier, and the separate control units. This system is for both cars and commercial vehicles

Of the two illustrations on the right, both of which are of Smiths engine speed indicators, that on the left is actuated by an a.c. generator and that on the right by the engine ignition system impulses

The Philips Auto-Mignon record player is easy to operate and is suitable for either 6 or 12 volt systems. The record is pressed gently into the slot and the rest of the operation is fully automatic, even to partially ejecting the disc, ready for subsequent removal, when it has been played

Division — shown for the first time last year, though in prototype form — is its shallow depth, which renders the design especially applicable to belt rail assembly. To judge from the demonstration mounting, this design is highly satisfactory in terms of elegant appearance and economy of space in the instrumentation area.

Pursuing the trend towards all-electric instrumentation, the Smiths concern has introduced two new types of engine tachometer, the a.c. generator and the ignition impulse units, both of which are used with a 25 milliampere indicating instrument. The a.c. generator equipment, now in production and used on Jaguar cars, is well suited for engines on which an appropriate drive is readily available. In other cases, the ignition impulse type, which is due to go into production in 1961, is the more suitable. With this design, a d.c. voltmeter is employed, and its movement is controlled by a two-transistor circuit incorporated in the indicating instrument.

There is no direct electrical connection to the engine ignition system, other than a supply lead from the battery, which serves as the source of energy for the voltmeter movement. Instead, a lead from the indicating instrument is connected to a pick-up coil, of few turns, surrounding the feed lead from the ignition coil. When the engine is running, the spark current impulses in this lead induce corresponding impulses in the pick-up coil, which trigger one of the transistors; this allows the second transistor to be switched on for a fixed period of time, thereby permitting current to flow from the battery to the voltmeter movement. Since the engine speed is directly proportional to the ignition system spark frequency, the induced impulses in the transistor circuit regulate, in proportion to the speed of the engine, the magnitude of the d.c. current in the voltmeter circuit. Failure of the tachometer can in no way impair the engine ignition, nor is the indication affected by any variation of the contact breaker setting. The scale calibration of the dial is, for all practical purposes, linear.

Electric horns

The matched De Luxe Alpine horns, introduced this year by the Wipac Group, constitute an attractively styled pair, the good appearance being emphasized by the all-chromium finish. These horns are of the high-pitch type and are claimed to give a penetrating warning of very pleasing tone. Their construction, finish and performance render them suitable for marine as well as automobile applications.

A useful accessory for obtaining the maximum performance from the electric horn on any vehicle is the AC-Delco relay of new design. It is a small and very compact unit, and is well sealed within an extruded aluminium case. This relay is suitable for use with either one or two of the Delco-Remy horns of the vibrating air column type.

Car radio

Car owners today have a truly remarkable choice of radio receivers, whether of the manually or push-button tuned patterns. All the leading manufacturers have a comprehensive range of styles, designed to suit almost all modern vehicles. On the Ekco stand, over fifty car sets were displayed, some being fitted into instrument panels to illustrate how effectively they blend with the interior styling. Introduced this year is a 6 volt version of the standard model CR903, to suit a range of Continental cars having 6 volt electrical systems.

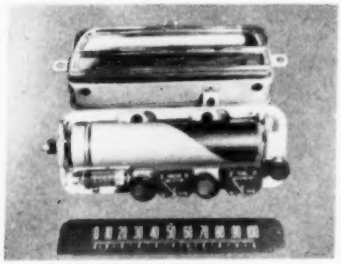
The main feature of the new Philips model 493VT is finger-tip selection of five different stations, four on the medium wave band and one on the long. This receiver has four valves and a transistor output stage; the tone control is continuously variable. The set is supplied complete with loudspeaker, mounting, and suppression equipment.

A new Pye nine wave band transistorized model, designated TCR3000/E, has a special cylindrical tuning scale: this shows, one by one, any of the eight band-spread wave bands on its medium wave, thus allowing selective tuning at a glance, right across the dial. For use with this model, as well as with the model TCR2000, is a new 6 watt amplifier that provides the extra power required for luxury multi-speaker installations or to overcome noisy conditions in fast sports cars.

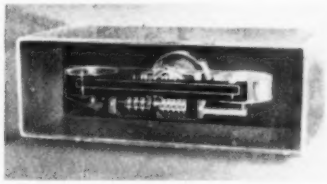
S. Smith and Sons (Radiomobile) Ltd. also cater for the Continental car market with their 6 volt, all-valve 20X and 500R receivers, for manual and push-button operation respectively. With its range of twelve car radio receivers, this organization covers every combination of short, medium, and long wave broadcasting throughout the world. These sets are for installation with 6, 12 or 24 volt systems.

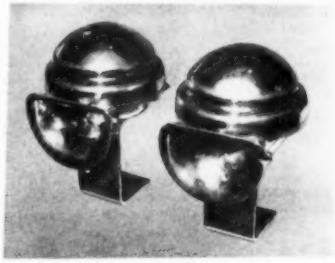
The speciality of Lee Products (Great Britain) Ltd. is a

Left: AC-Delco Safety-Liner speedometer, which operates on the magnetic drag principle. Right: The Wipac matched pair of De Luxe Alpine horns



Below: Smiths ribbon type speedometer, which is of a design readily incorporated in narrow rail or belt arrangements on facias





new portable radio receiver for cars. It is designated the Transmobil 2 model, and can be used as either a portable or an installed set. It is inserted in a special support mounted in the car, by virtue of which the connections to the car aerial and battery are made automatically. Another novel product of this firm is the Elpico Autovox CR-116 five-station, push-button tuned receiver.

For motorists who prefer their own particular choice of programme, the Philips Auto-Mignon record player should prove admirable. It is fully automatic and is suitable for either 6 or 12 volt systems; it is claimed to be the only record player made in this country for permanent installation in a car. Operating in conjunction with the car radio unit, it gives good reproduction of 7 in diameter 45 r.p.m. records. When installed in a car, all that is necessary is to switch on and press the selected record gently into the slot: the rest of the operation is done automatically, even up to partially ejecting the record at the end of playing.

Of interest to those contemplating installing car radio is the new Lumax model RA/2, three-stage fully collapsible aerial suitable for wing, scuttle or rear mounting. In its construction, heavily chromium plated brass tubing and stainless steel rod is employed, and the connections between the screened lead and the aerial are sealed in a block of polyester resin, for the complete exclusion of moisture and dirt. The aerial can be telescoped into a polythene tube, which is provided with a steady bracket to obviate any tendency to whipping when the aerial is extended. In its fully collapsed condition, the aerial projects only ½ in proud of its mounting.

For installation where manipulation of the aerial from the interior of the car is desired, the Radiomobile hand wound or electrically operated aerials, types AW45 and AW47 respectively, are eminently suitable. They are made of four chromium plated sections and, when not in use, retract completely into the wing of the car.

Car heating and air conditioning

In the range of Key-Leather products, the new units are the KL54 recirculation heater for the Ford Anglia, and the KL502 fresh-air heater for the Hillman Minx and Bedford CA van or Dormobile. Both types of heater have been specially designed as alternatives to the original equipment.

A new development of Smiths Motor Accessory Division is a rear screen demister. This is a relatively small, electrically driven fan unit controlled by a switch on the facia panel. As fitted in the rear parcel shelf, the unit project only 1½ in above the shelf. When it is in operation, a strong air current flows across the rear screen and demisting is effected in a matter of seconds. For Smiths fresh-air heating and ventilating equipment, new illuminated rotary controls, for original equipment purposes, are available to motor manufacturers. The internal illumination facilitates reading and operation of the controls of the heater system at night.

Bodywork

Few Significant Changes in Constructional Techniques or Styling, but Improvements in Finish and Trim; Challenge of the American Compact Cars

ALTHOUGH Earls Court contained very few examples of new quantity produced bodywork, there was a noticeable improvement in both the general and the detail finish. The standard of paintwork was significantly higher than before and, in the majority of cases, the colours chosen were suitable for the particular bodies. However, there were still certain instances of the use of colour schemes that were not in harmony with the general lines of the cars concerned.

Imperial Chemical Industries Ltd. have made an analysis of the colour schemes of the cars exhibited, of which the following is an abstract. Of the 328 cars examined, 4 were black and 324 in colour; of the 324 coloured cars, 55 were in solid colours, 100 in pastel shades, 44 in metallic finishes and 125 in two colours.

The 55 solid colours consisted of 31 reds, 2 tans, 11 greens, 7 blues, 1 grey, 2 violet and 1 turquoise. Of the 100 cars finished in pastel shades, 33 were in the ivory, cream and beige group; 24 were grey, 4 green, 28 blue, 4 yellow and 7 were lilac or lavender. The 44 metallic finishes were distributed as follows: 5 reds and maroons, 19 greys, 6 greens, 12 blues and 2 silver. In the case of the two-tone finishes, 108 of the total consisted of two solid colours, 15 comprised a metallic colour and a solid colour, and 2 were in two metallic colours. This list is certainly interesting, but it can hardly be taken as representative of the overall trend, because manufacturers tend, for obvious reasons, to rely on the brighter colours for exhibition purposes.

In general, bright metallic beadings were applied with restraint, but the problem of where and how to terminate the longitudinal waist beading was not solved by certain stylists. A considerable advance was visible in the use of stainless steel and aluminium for these beadings. In a few instances, the bright metal work around the windscreen and rear light was heavy, giving the body a ponderous appearance; slenderer mouldings would have resulted in a slimmer and more graceful aspect.

Most manufacturers have clearly given much thought to seating comfort and, although a scientific standard is lacking, this problem seems to be solved reasonably well in the majority of cases. The difficulty is, of course, to design a standard seat that will suit the wide range of statures, both male and female, of the general public. It is not sufficient to produce a seat for the average man—if he exists—because the average woman, too, must be considered, as also must the extremes of the tall man and the small woman.

A case can be made for a different approach, that of adopting as the standard a larger than average figure. If the average figure has been taken as the basis of design, and the actual driver happens to be of above average dimensions, there is very little room for even a smaller than average person in the rear seat. This criticism of inadequate leg room in the rear could be made regarding several of the quantity produced cars exhibited, but there were others that had obviously been designed round a driver of above average dimensions.

Another feature of criticism on some cars is that the relationship between the front seat, steering wheel and control pedals is such that the lifting of the driver's feet to or from the clutch and brake pedals causes the knees to foul the lower portion of the steering wheel rim. The forms of construction of cushions and squabs appear to be evenly divided among spring cases, foamed rubber, rubberized hair, resilient webbing and tension springs, and there are combinations of two or more of these classes of materials.

Increasing attention is being given to noise suppression, but greater use could be made of perforated or porous headlining materials, particularly of the more rigid type, to minimize the reflection of sound. Now that cars are faster and lower, dust sealing also becomes more important. The combination of higher speeds and a lower floor line results in an increase of pressure on the underside of the floor.

The traditional all-steel body is still by far the most popular, as also is the use of unitary construction for cars that are produced in quantity. So far, there is no indication that the Triumph Herald has started a trend away from this form of construction, although there are certain advantages in the use of a separate chassis frame and body. In fact, unitary construction seems more firmly established than ever because, in the U.S.A, manufacturers are turning increasingly towards it, particularly for their compact cars. On these, the problems are similar to those already tackled and overcome on this side of the Atlantic, whereas on the larger cars it is not an easy matter to obtain adequate stiffness without excessive weight, and the large panel areas make undesirable resonances difficult to avoid at some speeds.

Above and below are two versions of the Saab car, one with its fabric roof open and the other the station wagon with the rear seat folded

To save weight, on certain quantity produced cars, aluminium is used for some panels or sections. Glass reinforced polyester resin is still highly popular for units in small-scale production. In general, the production technique of plastics bodies is now well mastered, and the methods of construction used give ample rigidity while retaining the advantage of lightness. It would appear that the higher material cost and lengthy work cycle times of polyester-glass construction still render it unsuitable for large outputs.

In the majority of cases, bodies in large-scale production are pre-treated against corrosion before painting: a hot alkaline wash is followed by rinsing in water and chromate solution treatment, and then the structure is Bonderized or phosphated; next, the unit is either wholly immersed in primer, and then rotated to avoid runs and tears, or slipper dipped; that is, it is dipped up to the waistline in a tank of primer, and then allowed to drain naturally. This latter method gives good protection of all the metal work below the waistline, where most of the corrosion normally occurs.

Of all the British quantity produced saloons, the Jaguar is the only one on which a sliding roof—once a common feature—is still offered. This type of roof is, however, offered on certain Continental cars, and there were examples at Earls Court of the flexible panel that can be opened and folded. There is no doubt that, though an opening roof cannot provide the field of vision and the fresh-air motoring of the convertible top, it does provide greater comfort and pleasure than a solid roof, particularly in hot weather and when touring in hilly country. With modern production and sealing methods, an opening of some sort need not be troublesome or prone to leakage, but its incorporation must weaken the roof. Because of their flat roof panels and slender pillars and quarters, many current cars must already be less strong in this region than were their predecessors.

Extensive use is now being made of unreinforced p.v.c for the trimming of door panels; an advantage of this material is that it can be welded by local application of heat. Since it is also possible in this way to combine materials of different textures, it is likely that the use of plastics materials for trim purposes will further increase. By employing patterned metal dies, some good effects have been achieved in breaking up the large flat expanses.

The Humber Super Snipe and the Hawk four-door saloons have a common unitary body structure, and are a good example of what can be done to obtain two distinct characters by variations of the front and rear end treatment. On the latest Super Snipe, which is the Mark III version, the front end assembly is 3 in longer than that on the Hawk. A feature of the basic body shell is the deep wrap-round of the windscreen and rear light. Because of the windscreen wrap-round, its rearward raked pillars are well to the rear of the door hinge line; the A pillar is cranked forward below the waistline in such a manner that easy entry to the front seats is obtained. Access to the rear seat is facilitated by the wide doors; because of this width and the full wrap-round of the rear light, the only blind spots in the rear quarters are those caused by the D pillars.

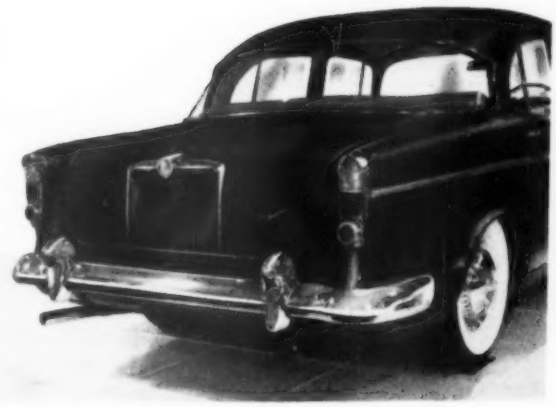
The front seat of the Super Snipe is of the bench type, divided in the middle; each portion of the squab is attached by Leveroll adjustable hinges. For the seating, spring cases, with moulded foam rubber overlays, are employed. Folding centre armrests are fitted to both the front and rear seats, and each rear door carries a combined armrest and door pull. The capping to the door windows and windscreen is covered with fabric-backed p.v.c.

An interesting point about the frontal treatment of the Super Snipe is that four headlamps are installed. They are arranged in pairs on a horizontal line, an arrangement that blends well with the wrap-round radiator grille and front

bumper layout. The waistline moulding has a long and pleasing sweep, which accentuates length, and so reduces the apparent height. At the rear the layout is neat, as can be seen from the illustration on the right.

The now familiar Austin A.55 Cambridge saloon, styled by Pininfarina, has been joined this year by the Countryman station wagon. In effect, this new vehicle is a six-light conversion of the saloon, and this arrangement has been obtained by extending the roof towards the rear. The general layout is conventional for such a vehicle, and the features include a horizontally divided rear door: the raked upper portion, containing the rear light, swings upwards on hinges sited at roof level, and the lower part hinges downward; both portions have stays to hold them open.

For the rear wing line, the rudimentary tail fin of the saloon has been retained, though slightly lowered. However, this fin now appears something of an afterthought because the bright metal beading that outlines it starts at the middle of the rear door, where it drops down almost vertically to the lower swaging on the side, and then continues rearward along this line. The windows in the doors have plated



Above: Grouped lamp arrangement at the rear end of the Humber Super Snipe. Below: In the Austin Seven Countryman, the petrol tank is on the left-hand side and the rear seat squab folds on to the floor

glazing-surrounds, but the quarter lights are not so equipped.

Separate front seats are fitted: they have moulded foam rubber cushions, and rubberized hair squabs with foam rubber borders. The rear seat cushion, too, is a foam rubber moulding on a spring case, and has a rubberized hair overlay. For the accommodation of really bulky objects, the seat cushion base can be tilted forward, on a linkage, and the squab hinged down to form a continuous platform with the rear floor. To provide sleeping facilities in the rear compartment, the cushion base, with the squab still folded down, can be moved still further forward; then the upper portion of the squab, which is separate from the lower portion, is swung forward and upwards, about a hinge at the top of the backing panel common to both, to serve as a headrest. This sleeping space measures approximately 6 ft × 4 ft, so two people can be accommodated.

In the Morris range is an almost identical vehicle known as the Oxford Traveller. The body shell is common to both, but there are the usual differences in external detail styling and interior appointments. For example, the Morris version has a bench type front seat, and the bright beading on the lower waistline swaging extends the full length of the car, without defining the leading end of the fin. Of the two, this decoration is to be preferred to that of the Austin model, since it blends the fin with the body. A detail of the Morris interior is the use of leather covering for both the seats, of which the front one has a resilient webbing base, whereas the rear one has a spring case of the conventional type.

The Austin Seven Countryman and the Morris Mini-Traveller are almost identical station wagon variations on the B.M.C. ADO 15 theme. In both cases, the underbody arrangement is the same as that of the 5 cwt vans introduced somewhat earlier; it provides a wheelbase 4 in longer than that of the saloon versions. The front portion of the body, as far as the B pillars, is identical with that of the saloon, but behind them it has longer roof and sides, new rear and quarter panels, and rear doors with a vertical division. Following the station wagon tradition, the rear half of the body and the rear doors have timber framing. This, however, being stuck on to the steel panelling, is simply for appearance. Because of the greater rear overhang, the overall length is about 10 in more than that of the saloons.

Both front seats are adjustable and tilt forward to give access to the rear. The seat cushions are of foam rubber, and the squabs of rubberized hair supported by resilient webbing. In orthodox fashion, the rear seat cushion can be hinged forward and the squab lowered to the horizontal, to form an extended floor for extra luggage accommodation. The seat and squab materials are the same as those at the front; all seats are trimmed in fabric-backed p.v.c, and material of the same type is used for the roof lining. There are carpets on the front and rear floors and load platform.

The battery and spare wheel are stowed below the load platform and are covered by a detachable panel. A kidney-shape petrol tank is fitted on the left-hand side, over the rear wheel arch. The side lights extend from the B pillars to the rear quarters, and each comprises two sliding glass panels. As on the saloons, there is generous accommodation for parcels and other small items: in addition to the full-width shelf on the dash, there are pockets in each door and on each side of and below the rear seat.

It is of interest that, before painting, all the bodies produced by B.M.C. are given a complete immersion in zinc phosphate solution and then primer paint, which therefore covers the whole of the steelwork, both outside and in. After dipping, the body structure is rotated about its longitudinal axis, to ensure that every surface is evenly covered without runs and tear drops. Dust sealing and sound insulation are taken care of by the extensive use of a bituminous compound, and the roof is insulated by means of felt applied to its underside.

Though not new, the two-door, four-seat saloon body of the Aston Martin DB4 remains an impressive example of its type. This body, which is built on a steel platform chassis, has a light tubular steel framework and is panelled

Left: On the Mark III version of the Humber Super Snipe, the front end assembly is 3 in longer than that of the Humber Hawk, but both have a common unitary body structure

Below: Zagato two-door sports coupé body on the well known Aston Martin DB4 chassis

Below: The Standard Vanguard Six has the side lights and flashing indicators grouped in a panel on each side of the grille

Below, right: Features of the Ford Anglia include a deep windscreen and a compactly styled radiator grille and lamp assembly

Two views of the Hillman Husky. The rear portion of the roof is transversely swaged and overhangs the door at the back. Another feature is the recessed rear lamp groups

in aluminium alloy. The body-chassis unit is phosphate treated to minimize corrosion, and is amply insulated against noise. As would be expected in a car of this class, all the seats are trimmed in leather. The front seats are of the bucket type, and the squabs are adjustable by means of Chapman-Reutter hinges.

Also shown was a DB4 two-door two-seat sports coupé, built by Carrozzeria Zagato of Milan. This is of similar construction to the saloon but is more compact, lighter and, presumably, faster. All the trim was in leather. A feature of this car was that safety harness was fitted: the diagonal bracing straps pass through a staple on top of each seat squab, and are anchored at the rear to a stout metal bracket under the floor: this bracket extends between the chassis frame side members and the propeller shaft tunnel pressing.

No bodywork changes of any consequence have been made by Ford, whose Anglia model—noteworthy for its rearwardly raked rear light—remains one of the better looking and more individually styled small cars. In connection with the earlier remarks on bright beadings, their application to the Zephyr and Zodiac models calls for some comment. On these otherwise shapely and well styled bodies, the stylists appear to have been at a loss as to how to treat the leading end of the side beading, in the region of the headlamp. This beading finishes abruptly on the Zephyr, but in a way that detracts from the general line, whereas on the Zodiac it ends with a short downwardly inclined portion, the purpose of which is to make a break line for two-colour painting; the result, however, is to make the front end look too heavy.

Favourable comment is called for regarding the trim of the Anglia body. Seat trim in two colours is offered: it consists of p.v.c. borders round panels of woven rayon material. On this car, all the carpets are rubber backed and are moulded to fit the contours of the floor, thus avoiding a multiplicity of joints and loose pieces.

Since last year, a new version of the popular Hillman Husky station wagon has been introduced. Though it follows the general lines of its predecessors, in being of the two-door, four-light layout, it differs in a number of respects. The roof panel is 1¼ in lower than before, and its resistance to drumming has been increased by the embodiment of transverse fluting to the portion behind the B pillars. A slight peak at each end helps to prevent water from running on to the windscreen and rear light.

A contribution to safety has been made by considerable increases to the glass area. In line with the practice adopted for the Rootes 1½ litre cars, the windscreen has been deepened and widened, so its area is no less than 21 per cent more than hitherto. The depth of the rear light has been increased by nearly 1½ in. Incidentally, the Husky is unusual among station wagons in having a single, wide rear door, hinged at the right-hand side. The front seats are of improved design, having wider squabs with increased curvature. On account of the reduced height of the roof, they are mounted ¼ in lower; adequate leg room has been provided by moving the seats 1¼ in to the rear.

Rear end of the latest version of the Standard Vanguard

There are no external differences, other than the name badges, between the four-cylinder Standard Vanguard and the new six-cylinder version, known as the Vanguard Luxury Six. Internally, the most obvious difference is a modified facia layout on the Six. The hooded instrument panel is mounted immediately in front of the steering wheel, and displays a compact and symmetrical grouping of the subsidiary instruments and switches around a large circular speedometer. A two-spoke wheel is employed, to give full visibility of the panel when the car is travelling straight.

It is well known that the Mercedes-Benz company pays unusual attention to the safety aspects of car design. This fact is evident not only in the excellent handling qualities of its products, and in their structural strength and rigidity, but also in such important details as the door locks. In road accidents, many injuries are caused because the doors fly open on impact, resulting in one or more of the occupants being thrown out on to the road. To minimize the risk of this occurrence, the Kiekert locks fitted to the 220S car shown at Earls Court embody a device that keeps the doors shut even in a severe collision. These locks are of the so-called block type and the doors close unusually quietly. The inside handles are very small and neat, and are recessed partly into the door; just enough of the lever end protrudes for easy operation.

Since the previous London show, the Triumph Herald range of a saloon and a coupé has been augmented by a convertible model. Constructionally, this car is built on identical lines with its predecessors, in that the body comprises a number of sub-assemblies bolted to each other and to the robust backbone type chassis frame. In fact,

The B.M.C. ADO 15 Mini-Traveller is basically similar to the 5 cwt van: the front end of the body is identical with that of the saloon, but the rear end is longer, the wheel base having been increased by 4 in and the overall length by about 10 in

Rear end of the Oldsmobile F-85. Horizontal features are accentuated, and the skirt panel below the bumper gives a neatly finished appearance to the back end of the car

Right: The styling of the front end of the Oldsmobile F-85 is in keeping with that of the rear, illustrated above. The four headlamp installation on each side of the grille is neat and the other lamps are mounted immediately below the wrap-round bumper

In the illustration at the foot of this page, the interior layout at the front of the Austin Seven is shown. The facia panel is purely functional in design and there is a large container for parcels and other small articles at the bottom of the door

below the waistline, there is no difference between the three.

In respect of its seating accommodation, the convertible falls mid-way between the other two. The saloon is a reasonably full four-seater, and the coupé can be fitted with an occasional rear seat which, however, is really only suitable for children because of the headroom restriction imposed by the steeply raked rear light. In the convertible, the rear decking is shorter than on the coupé to increase the rake of the rear seat squab, and the rear of the folding head has a less pronounced rake. Consequently, the seat could be occupied, for short distances, by two adults of medium size. The head itself is well designed: it is based on a light tubular framework, and is simple to erect and stow.

Although the handsome Rover 3 Litre saloon is substantially unchanged, several alterations have been made to improve the refinement and finish. Externally, all the bright trim above the waistline is no longer chromium plated but is of stainless steel. The quantity of polished wood used internally has been increased, and it now completely surrounds the side lights. Another change affects the fresh-air ventilators set in the top rail of the dash: they are smaller than before and in the outlet is embodied a butterfly type valve that can be set at any position, through a range of 180 deg, to provide full control of the air flow.

Hitherto, the interior lamps in the rear of the body were relatively large, circular units and were installed in the quarters, but they are now smaller and are mounted above the doors. The pleating of the leather seat covering and the headlining has been improved, and a coat hook is now fitted to each side of the roof. In the rear, two ashtrays are provided instead of the previous one. The rear-view mirror has been increased in size and is mounted lower than before, to extend the field of vision. Another improvement is the insulation of the bonnet lid by means of a glass fibre panel.

An interesting optional extra on this Rover model is a detachable division, the installation of which converts the differs considerably from the 541R, which it supersedes. As hitherto, the body is constructed from glass reinforced front seat and the roof. It is secured by wing nuts to brackets at the top and the bottom, the top ones being pivoted to allow the front seat to slide to and fro. The front-to-rear dimension of the rear seat cushion appears to be rather small, but this is partially compensated for by the use of foot wells that increase the effective height of the cushion from the floor.

The latest Jensen two-door sports saloon, the 541S model, differs considerably from the 541R, which it supersedes. As hitherto, the body is constructed from glass reinforced

Two views of the Buick Special. An interesting feature is the treatment of the front wing in conjunction with the deep moulding of the whole of the body side

polyester resin, the finish of which is outstandingly good, and the tradition of a sleek and graceful appearance has been maintained. However, the track at both ends has been substantially increased; the greater width and restyling of the body have resulted in a marked improvement in the accommodation. This is particularly noticeable in the rear seat, which now provides comfortable space for two adults. The boot capacity, too, is greater than before.

Because of the low build of the car, the transmission tunnel is unavoidably prominent, but use is made of it to provide a wide central armrest for the occupants of the rear seat. In general, the interior is luxuriously equipped and well finished, and an indication of current trends is the provision of safety harness for the front seats. The instrument panel has a neat and functional layout, and is flanked on one side by a glove box with a lid that can be locked.

Ford Thunderbird Tudor hard top. The bottom of the rear light is let into the decking panel, thus obviating the need for a polished metal moulding or a beading finisher

A few changes have been made to the Vauxhall Victor since last year, but they are of a minor nature only. The radiator grille has been restyled and the depth of the wrap-round rear light has been increased to give better vision to the rear. To improve the stiffness of the boot lid, a series of vertical flutes is now pressed in the lower part of the panel.

Of the second crop of American compact cars, the Buick Special and the Oldsmobile F-85 saloons are of particular interest, in that the same basic body structure is used for each, though they look very different. In fact, it is indeed difficult to see how this has been accomplished. So far as appearance is concerned, these models are an improvement on the American cars of a year or two ago in that bright mouldings are applied only sparingly on the exteriors; where they are used, they enhance the general appearance.

These two cars are very elegant, in that none of the lines or proportions are out of harmony with others. The treatment of the side panels is perhaps unusual, giving an attractively low and wide impression, and in each case the radiator grilles, bumpers and twin headlamp groups give the impression of being conceived relatively to each other. At the rear ends, the treatment is similarly satisfactory. Both bodies feature the hard waistline edge now popular in the U.S.A; below this edge the side panels are appreciably undercut, giving a sculptured effect. On the Buick, a secondary, lower ridge extends from just above the front wheel, back in a gently falling line to the rear bumper, which has hardly any wrap-round. In contrast, the secondary ridge on the Pontiac curves downward behind the rear wheel, following the lines of the cut-out, and the bumper ends are taken well round the sides. At the front, the bumper arrangements are transposed, in that the Buick has the wrap-round and the Oldsmobile has not.

Few people will mourn the fact that neither car has tail fins, though their disappearance means that the rear corners are less sharply defined. Another commendable feature of both cars is that the deep windscreen has only a moderate transverse curvature; since its pillars have a rearward rake, entry to the front seats is considerably easier than where the dog-leg type of pillar is used in conjunction with a full wrap-round of the screen.

The rake and curvature of the Buick and Oldsmobile rear lights match those of the screen. In both instances, the side window layout can be regarded as being intermediate between four-light and six-light styling. There is a small triangular window, with a vertical leading edge, behind the window of each rear door. The pillar of this rudimentary quarter light is offset appreciably ahead of the trailing edge of the door, which is vertical up to the waistline; above this point it runs forward and inward, over the body shoulder, to meet the pillar.

There is no doubt that, in the design of the new compact cars, the Americans have struck a new and generally admirable vein of styling. This owes much to European

thought, in its reliance on line and form rather than decoration, but it is, nevertheless, individual. The earlier excesses have apparently been overcome—it is to be hoped, permanently — and, in terms of appearance, the latest products can challenge those of any other country.

There has long been a need for an inexpensive device for varying the squab angle of front seats. An adjustment of this kind is of considerable value, in two respects: not only does it enable individual preferences regarding the driving posture to be satisfied, but it allows a driver to vary his attitude during a long journey, thus appreciably reducing fatigue. The ability to sleep in reasonable comfort in the car, by lowering the squab to the horizontal position, is probably less of an advantage in Britain than in other countries where distances are greater.

Because of their high cost, the adjustment systems hitherto available in this country have only been applicable to the luxury type of car. On this account, a new Widney system shown by Hallam, Sleigh and Cheston Ltd. offers considerable promise: the manufacturers estimate that the extra cost of equipping both front seats should be no more than £10. This patented system was designed in France, and a French-built version is available for the Peugeot 404 car. It is known that Fiat has taken up the manufacturing rights for Italy, and that Simca and Panhard have adopted the mechanism. Hallam, Sleigh and Cheston have the manufacturing rights for Britain, the other Outer Seven countries and the British Commonwealth.

The Widney adjustable unit provides 90 deg of angular travel of the squab, in steps of 3 deg. Two units are fitted to the base framework of the seat, one at each side. In essence, a unit comprises an annulus gear, free to revolve on a fixed spindle and attached to the squab frame, two toothed pawls and their actuating yoke. This yoke is moved by a lever to engage or disengage the pawls: engagement locks the squab in position, and release enables it to be moved. The lever of the outboard unit is operated by the occupant of the seat and is connected by a cross tube to that of the other, thus synchronizing their action. Inadvertent movement of the squab is prevented by spring loading the levers towards the locked position; in addition, the squab is spring loaded towards the vertical.

During the motor show, the Institute of British Carriage and Automobile Manufacturers held its annual competition for private car coachwork, by permission of the Society of Motor Manufacturers and Traders Ltd. This competition is, of course, open only to British car manufacturers. The gold medals for the various classes were awarded as follows:

Class 1 Park, Ward and Co. Ltd. Enclosed limousine on a Rolls-Royce chassis
Class 2 H. J. Mulliner and Co. Ltd. Two-door saloon on a Bentley Continental chassis
Class 3 Park, Ward and Co. Ltd. Drop-head coupé on a Bentley chassis
Class 4 Ford Motor Co. Ltd. Anglia de Luxe saloon
Class 5 Ford Motor Co. Ltd. Consul de Luxe saloon
Class 6 Ford Motor Co. Ltd. Zodiac saloon
Class 7 Wolseley Motors Ltd. 6/99 saloon
Class 8 British Light Steel Pressings Ltd. Humber Super Snipe saloon
Class 9 Jaguar Cars Ltd. Mark IX saloon
Class 10 Vanden Plas (England) Ltd. 4 litre Princess limousine
Class 11 Alvis Ltd. Two-door TD.21 saloon
Class 12 Thrupp and Maberly Ltd. Sunbeam Rapier convertible coupé
Class 13 Sunbeam Talbot Ltd. Alpine open sports car
Class 14 A.C. Cars Ltd. Ace open sports car
Class 15 Austin Motor Co. Ltd. A.40 Countryman
Class 16 Humber Ltd. Super Snipe Estate Car.

Of these sixteen different classes, ranging from the costliest cars down to utilitarian vehicles, all were judged on the following points: general exterior design; interior design and finish; comfort; exterior finish; general visibility; accessibility for driver and passengers, and position of all controls; luggage accommodation; body sealing; heating and ventilation; accessibility of tools and spare wheel. Additional marks were awarded for special features of a practical nature.

Multiplicity of lamps at the front end of the Vanden Plas Princess 3 litre saloon car

At the rear end of the Vanden Plas Princess 3 litre saloon, the waistline moulding that extends from the front headlamps to the base of the tail lamp cluster is extended horizontally across the boot lid

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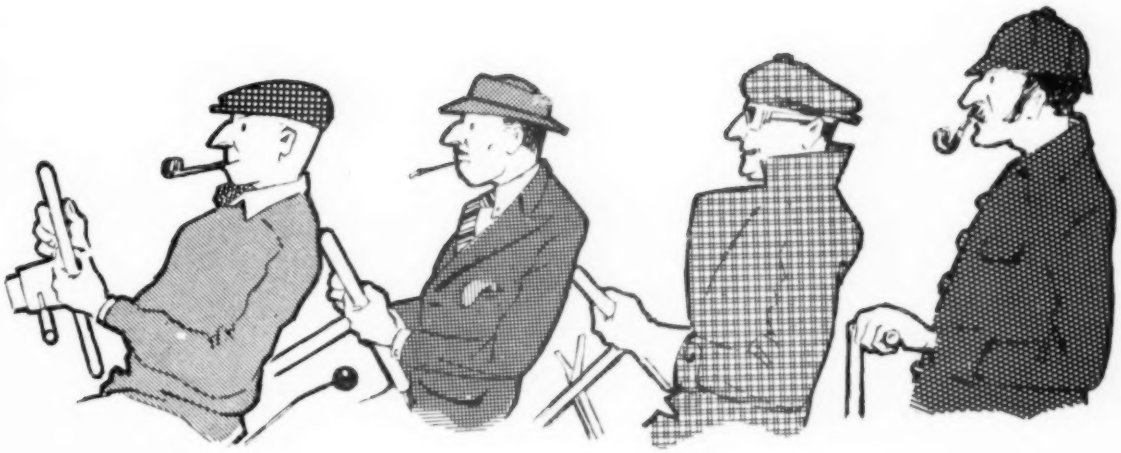

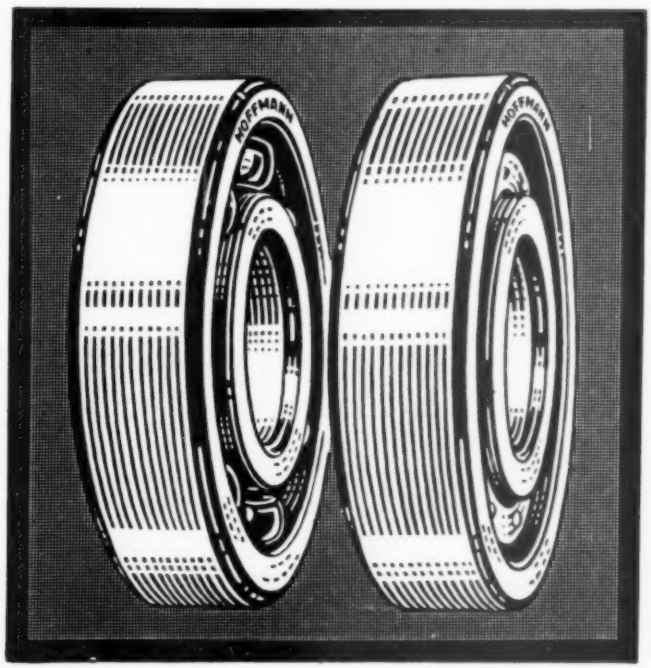

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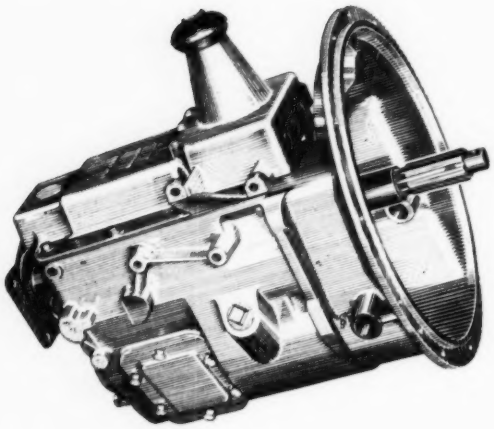

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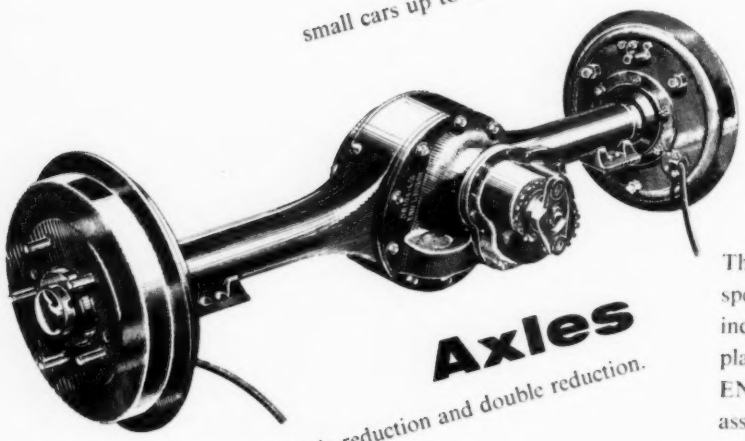

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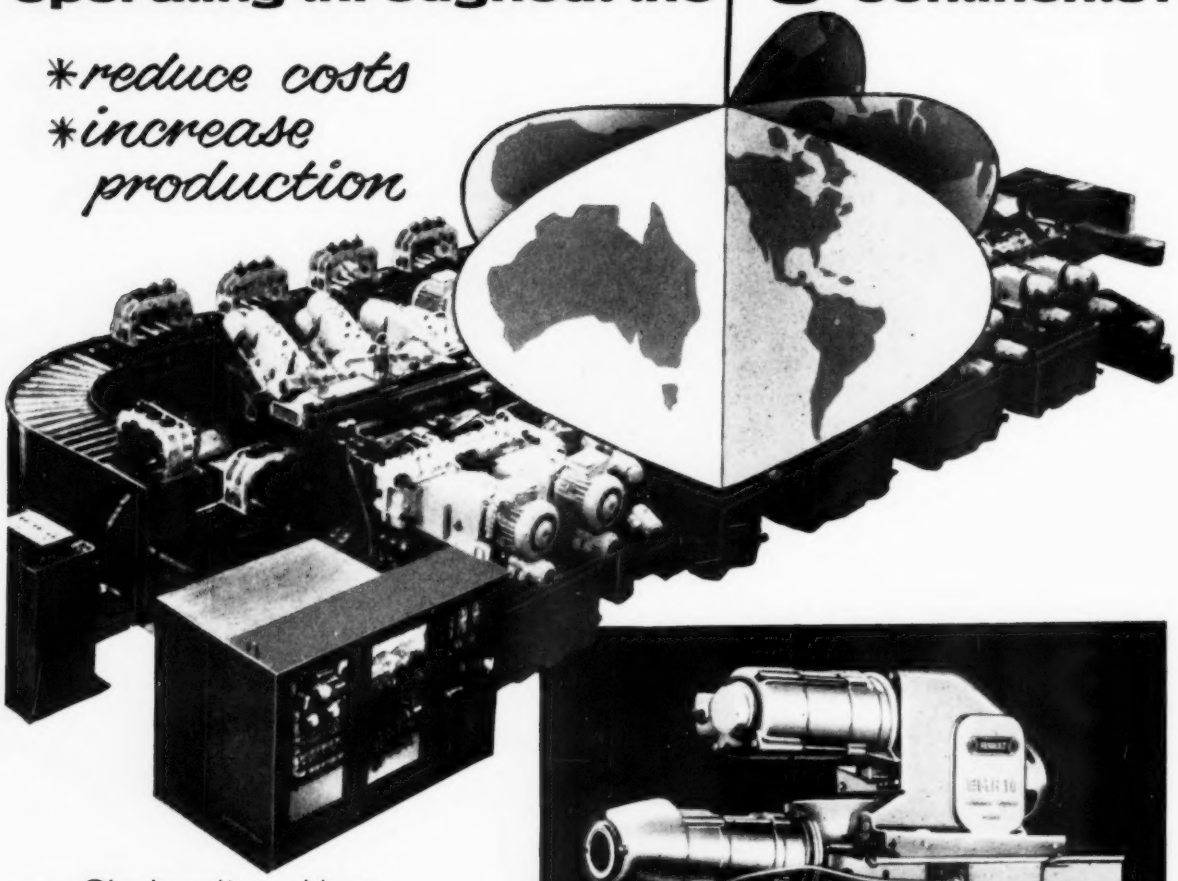

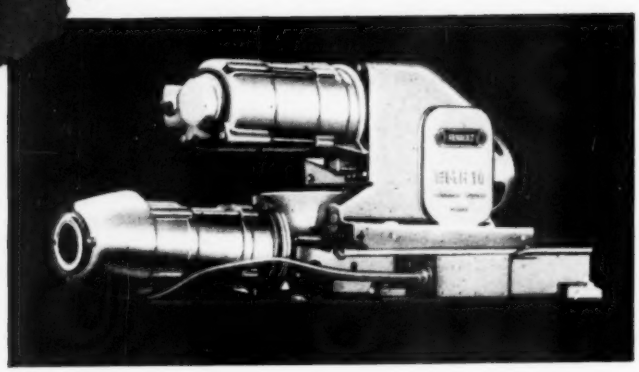

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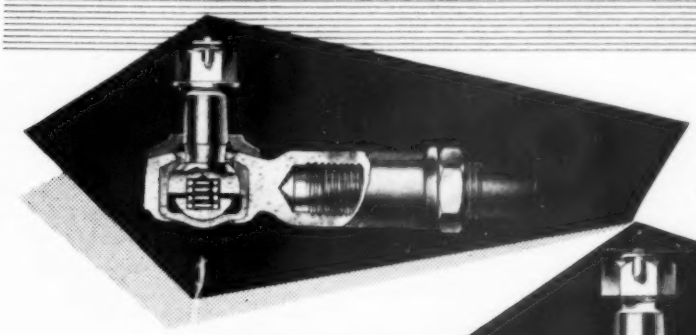

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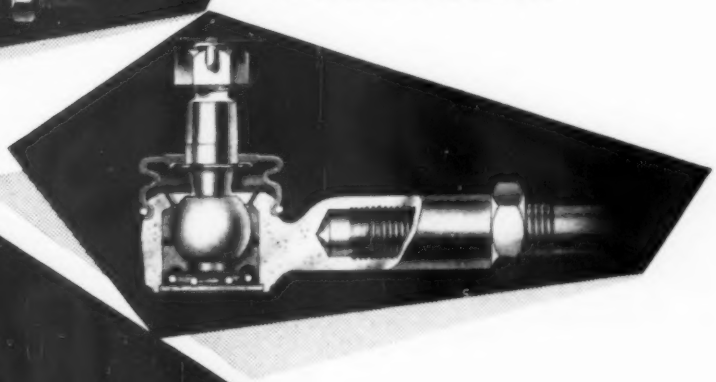

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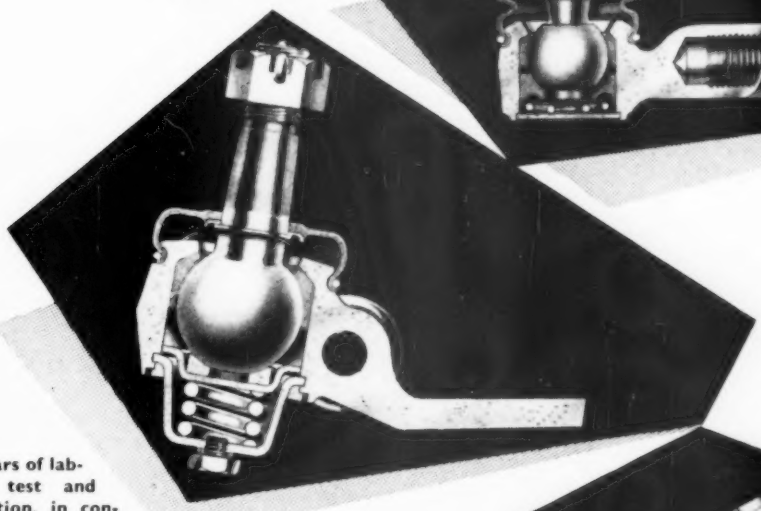

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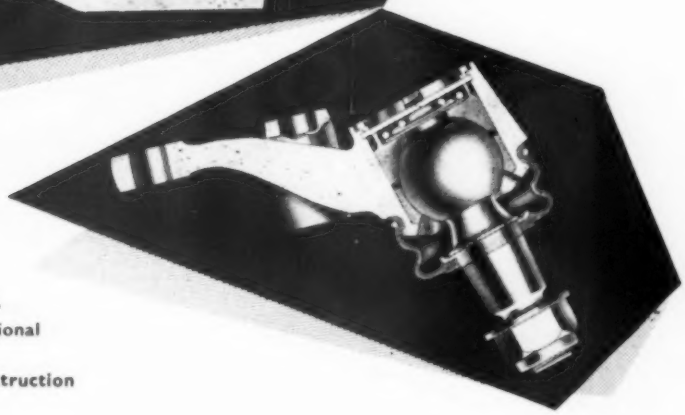

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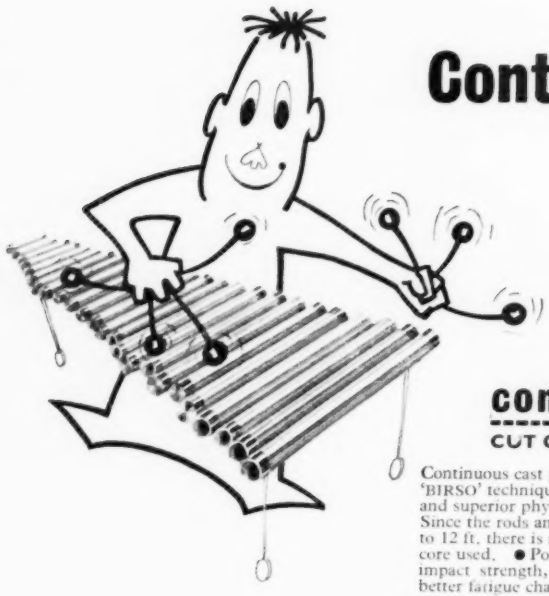

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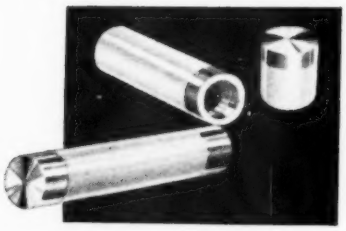

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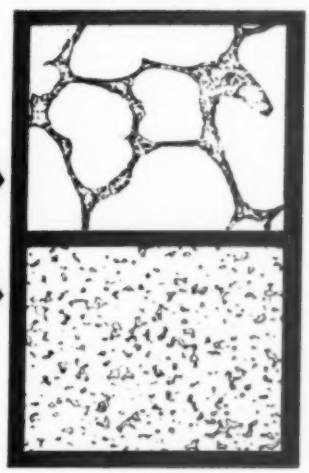

Micrograph of aluminium — 20% tin, as cast.

Micrograph of aluminium — 20% tin, rolled and annealed.

The latest development in Plain Bearings, defined above in technical terms, offers manufacturers and private motorists—

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Our licencees, TRIONE of Turin, supply FIAT and S.A.M.E. (Fratelli Cassani).

RETICULAR TIN-ALUMINIUM bearings are an exclusive product of the Glacier Metal Company Ltd., and are also marketed by their licencees.

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THE GLACIER METAL COMPANY LTD · ALPERTON · WEMBLEY · MIDDLESEX.

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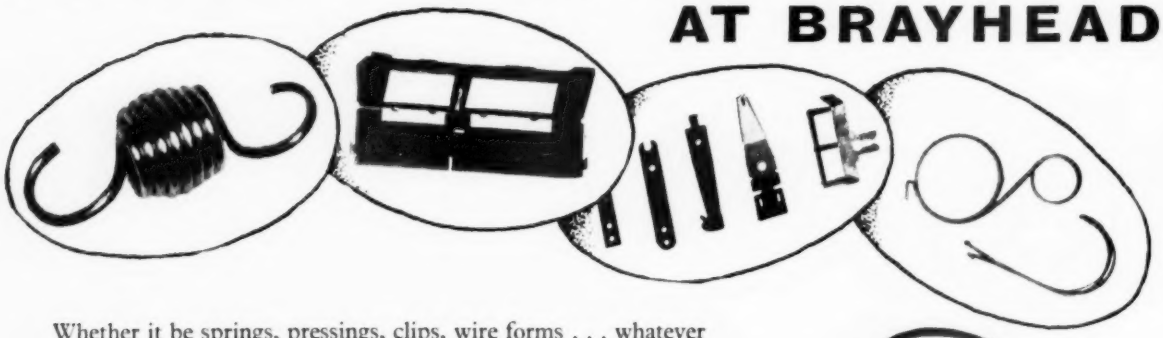

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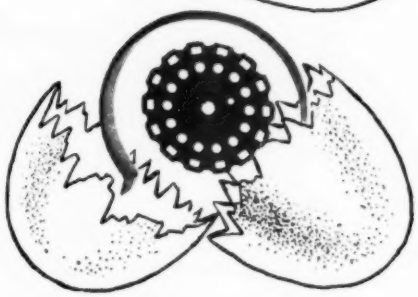

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750,000 miles

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Herewith we wish to certify that Omnibus No. 2., of "SCANIA VABIS" make, Motor No. 62 1 79, Chassis No. 91 9 70, which operates on the Lima-Ica Line, has run 1,200,000 kilometres without it being found necessary to dismount the engine for repair.

Lima, 9th April, 1957
PERUVIAN OMNIBUS COMPANY LIMITED
J. BLUME T.
Principal of the Transport Department

The undersigned, PUBLIC NOTARY AND COMMISSIONER FOR OATHS, CERTIFIES that Mr. JUAN BLUME TRAVERSO, proving his identity with his electoral papers number six hundred fourteen thousand five hundred and ninety four and his military papers number eight hundred and seventy seven thousand six hundred and sixty two, was present in the offices of the aforesaid Public Notary, with the object of having legalised his signature in the DECLARATION which he has signed as Technical Principal of the Transport Department of the Peruvian Omnibus Company Limited, ratifying before me the said declaration which he now repeats and says as follows: "Herewith we wish to certify that Omnibus number two, of "SCANIA VABIS" make, Motor number sixty two thousand one hundred and seventy nine, Chassis number ninety one thousand nine hundred and seventy, which operates on the Lima-Ica Line, has run one million and two hundred thousand kilometres without it being found necessary to dismount the engine for repair", which he signs again in my presence, in Lima, on the thirteenth day of the month of April of the year one thousand nine hundred and fifty seven.

J. BLUME T.

DR. DANIEL CESPEDES
NOTARIO PUBLICO Y DE HACIENDA

This is a translation of an affidavit drawn up by Dr. Daniel Cespedes, Notario Publico y de Hacienda.

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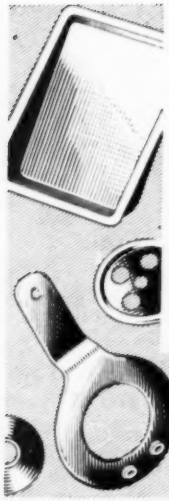

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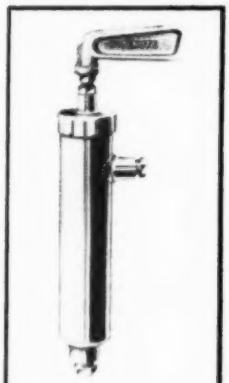

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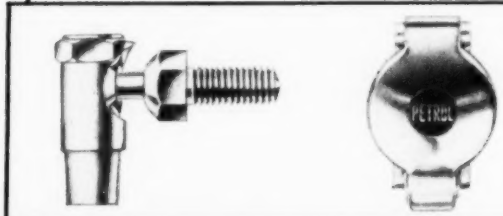

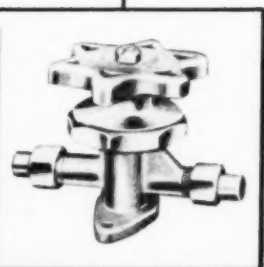

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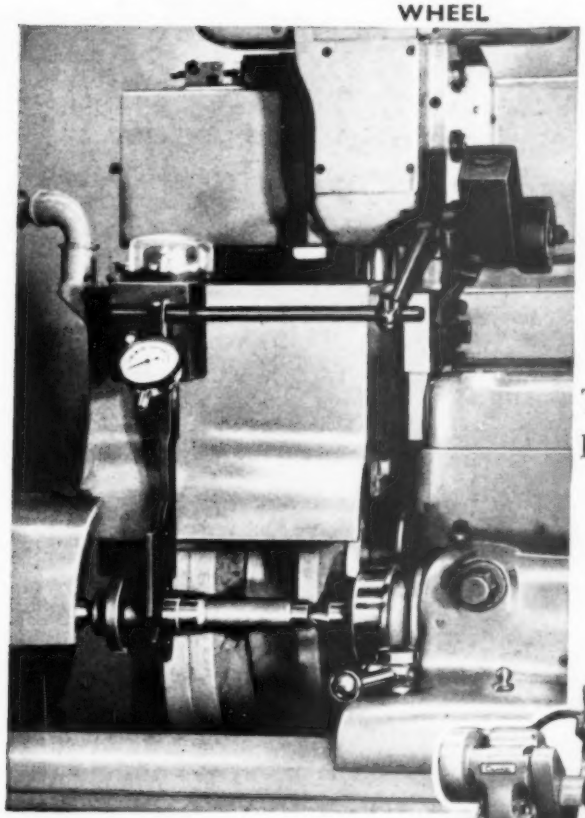

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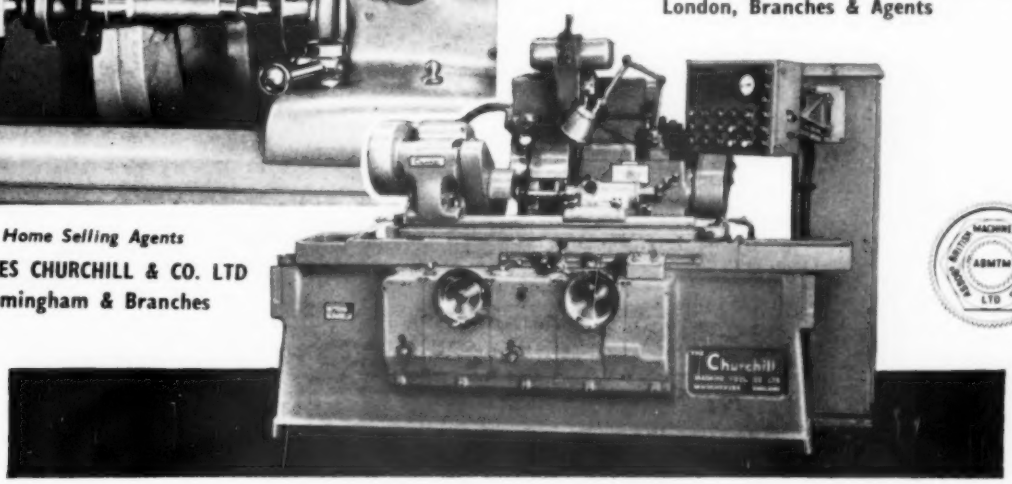

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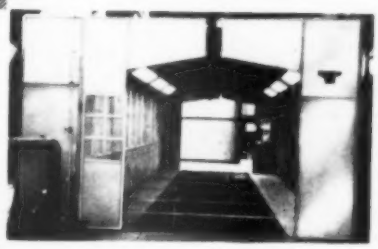

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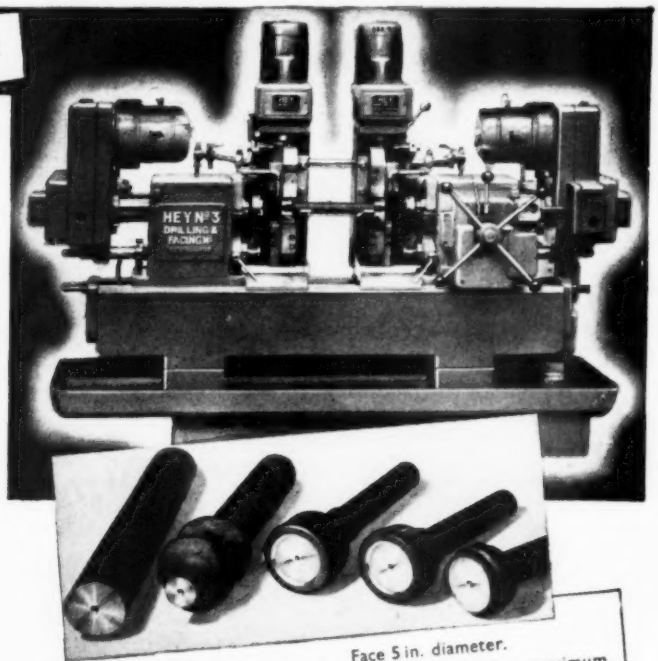

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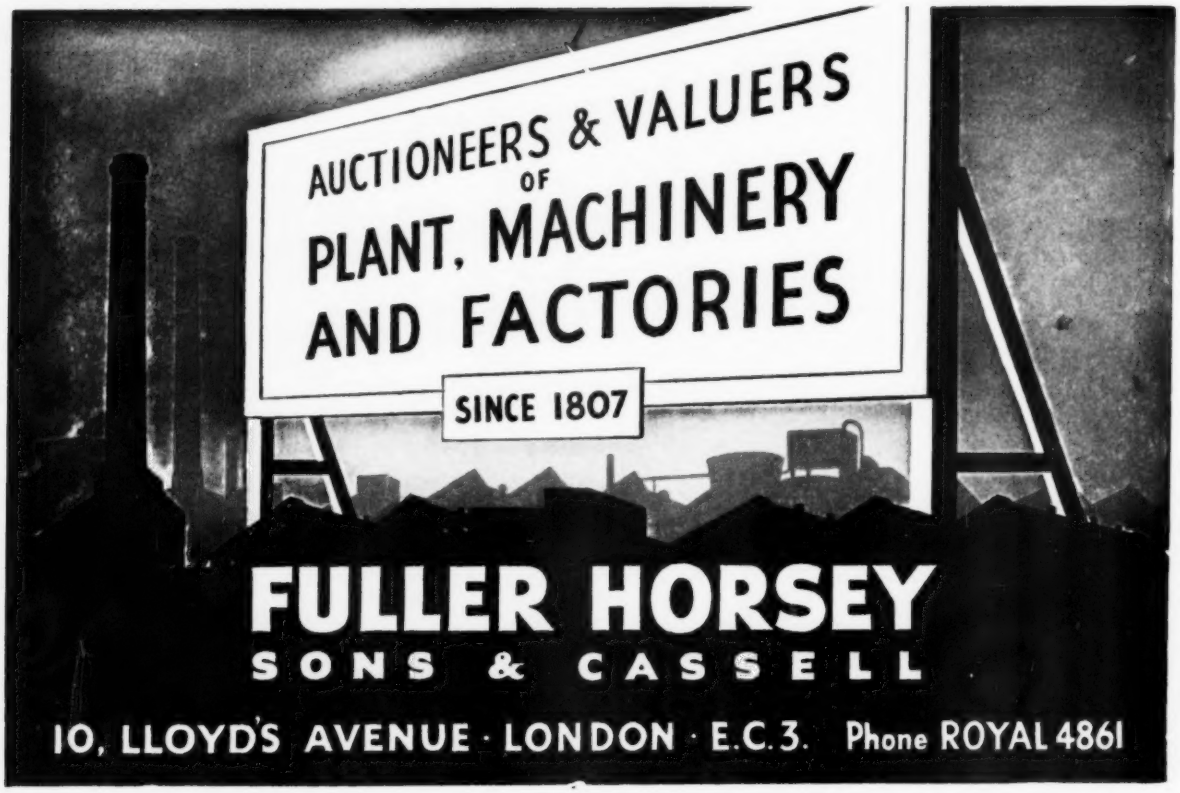

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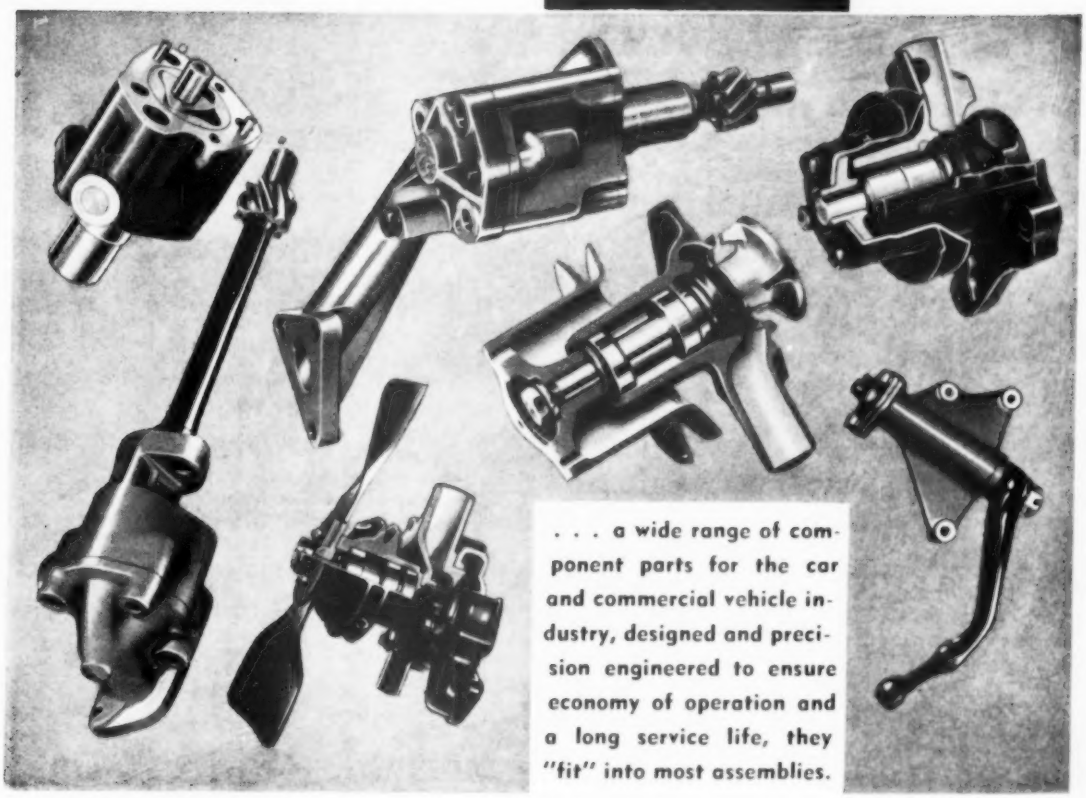

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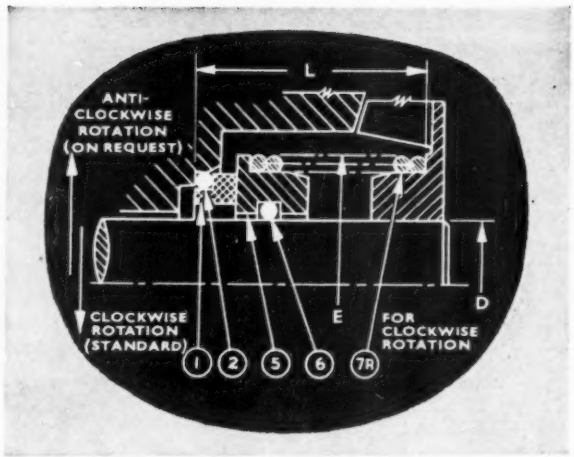

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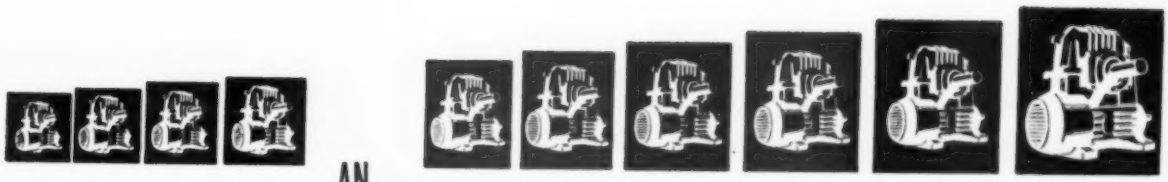

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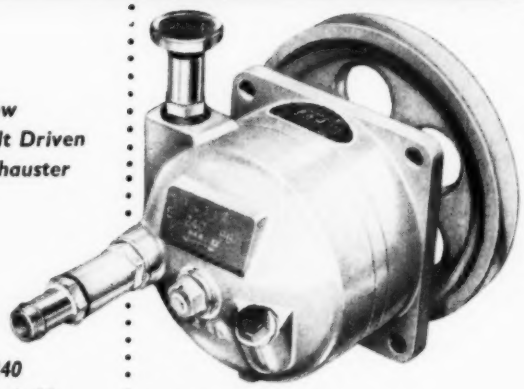

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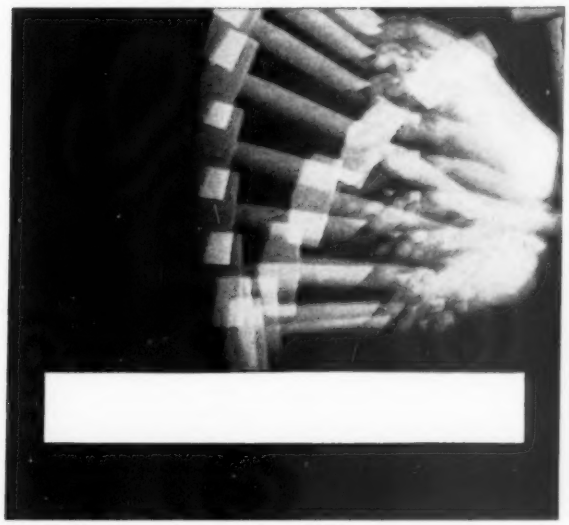

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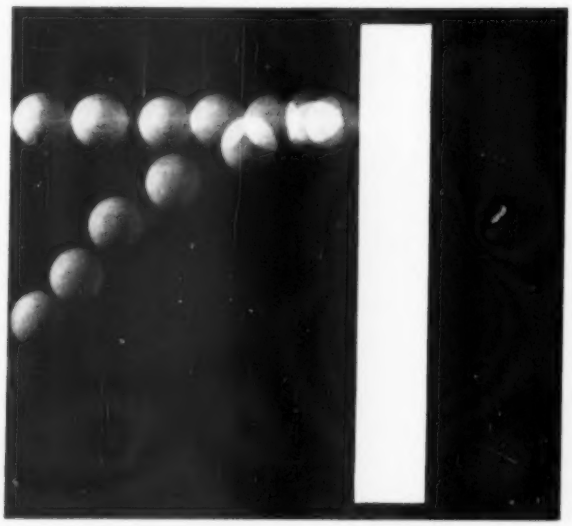

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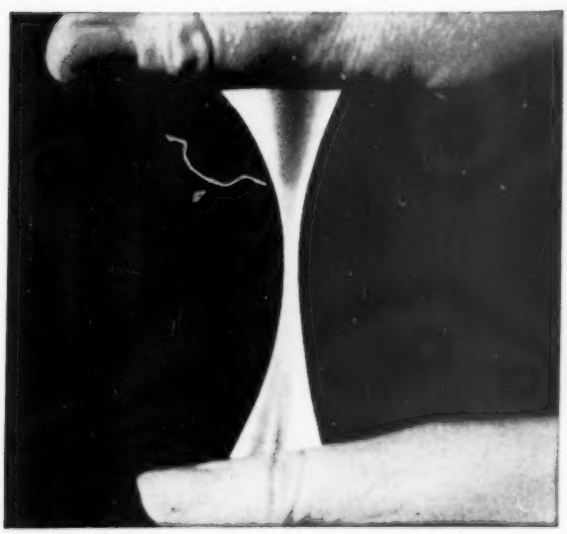

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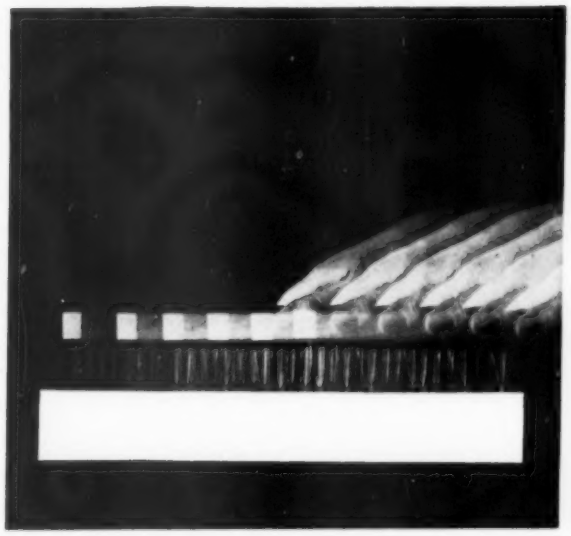

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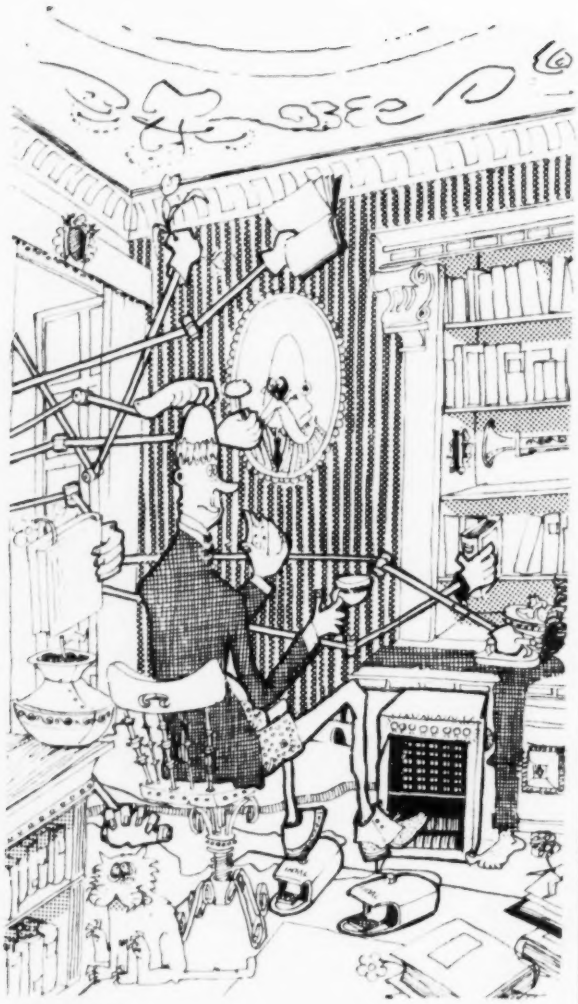

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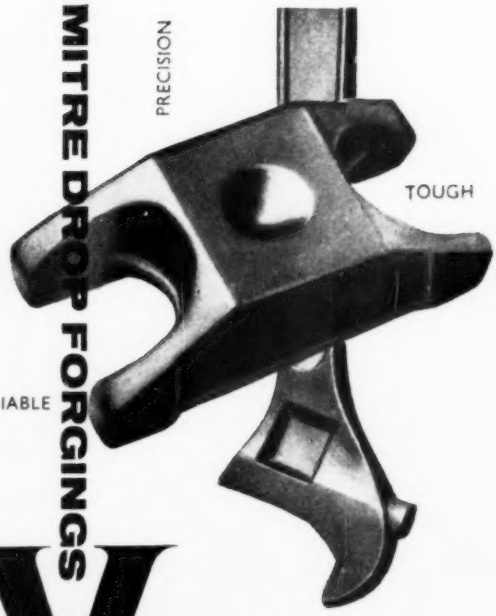

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(And rane cayme downe in torents)
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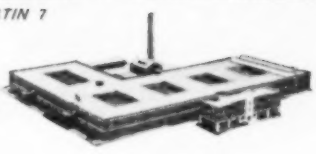

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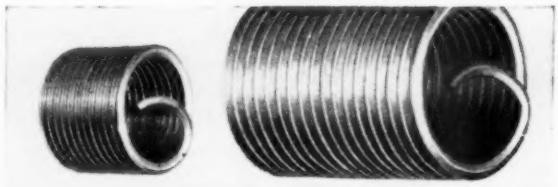

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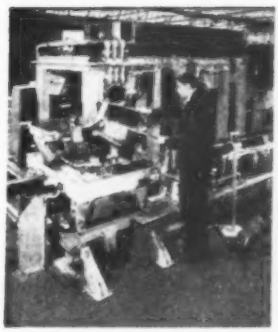

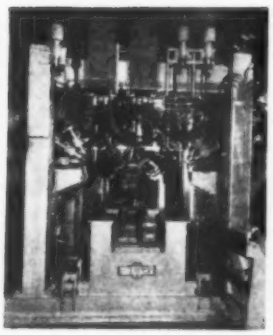

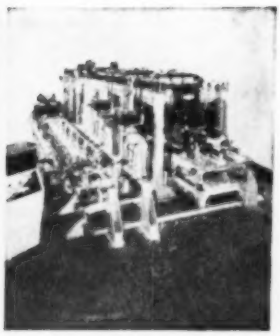

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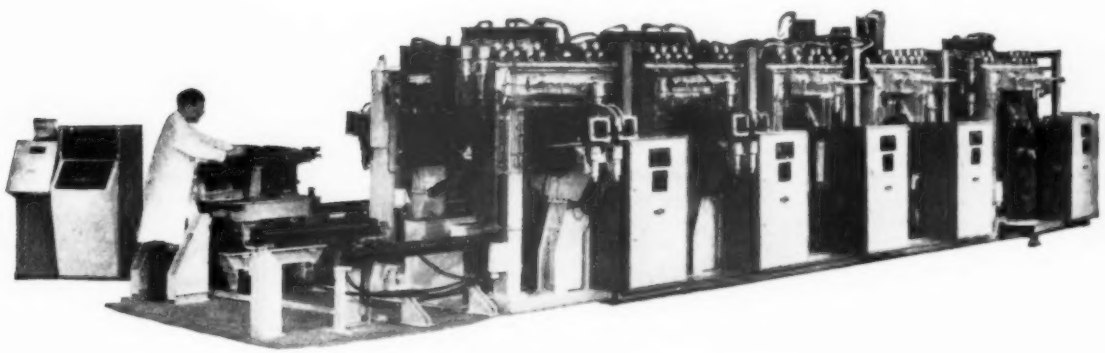

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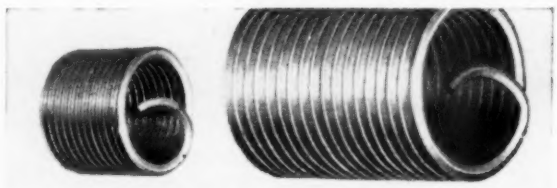

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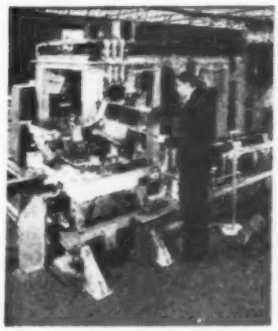

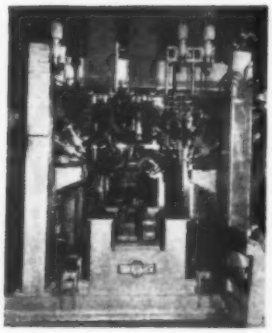

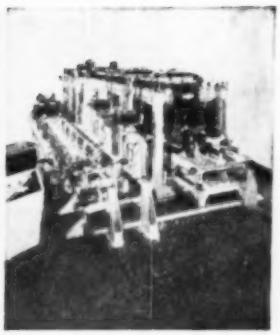

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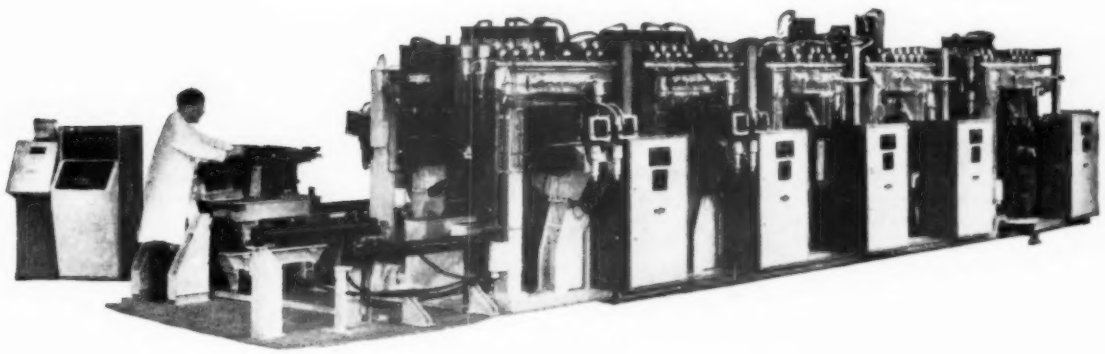

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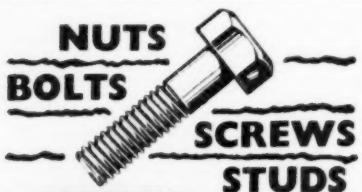

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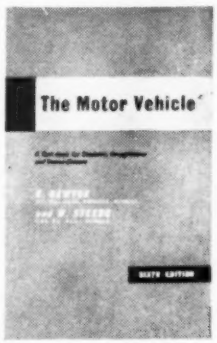

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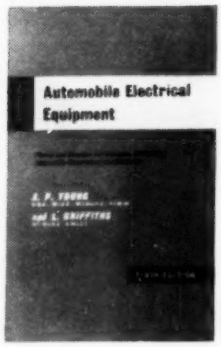

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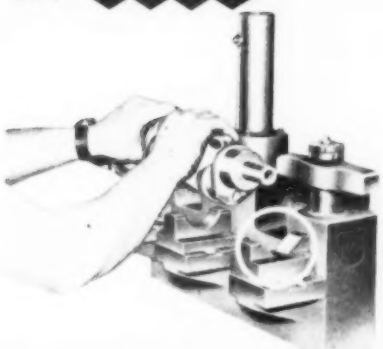

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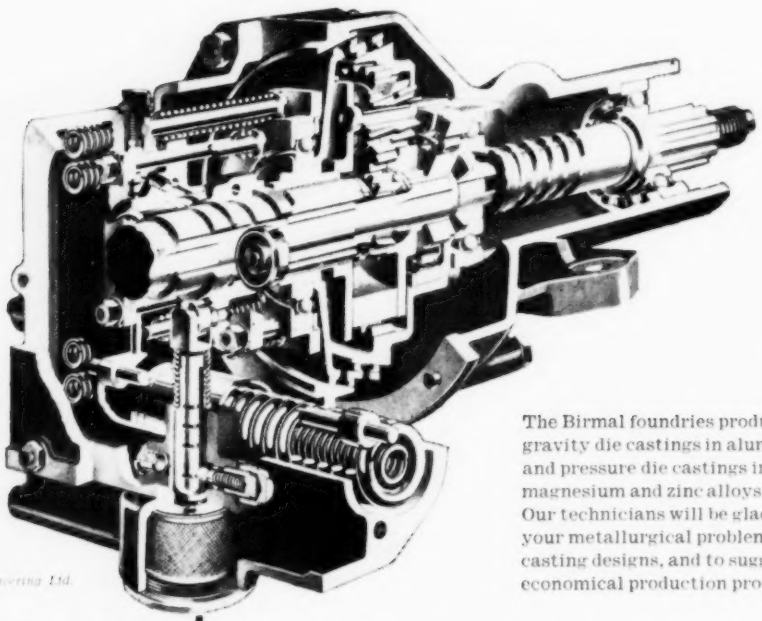

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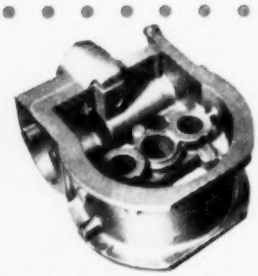
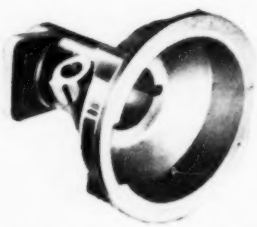
The Birmal foundries produce sand and gravity die castings in aluminium alloys, and pressure die castings in alumium, magnesium and zinc alloys. Our technicians will be glad to discuss your metallurgical problems, casting designs, and to suggest the most economical production processes.





BIRMAL

Birmingham Aluminium Casting (1903) Co. Ltd

BIRMID WORKS SMETHWICK 40 STAFFS